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OF THE

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FOR THE

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REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE THIRD SESSION OF THE FIFTY-THIRD CONGRESS.

VOLUME II—IN SIX PARTS.

PART 3.

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1894.

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REPORT OF MAJ. T. H. HANDBURY, CORPS OF ENGINEERS.

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REPORT OF MAJ. F. A. MAHAN, CORPS OF ENGINEERS.

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REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

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REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS.

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REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1389; ship channel in Galveston Bay, Tex., 1396; channel in West Galveston Bay, Tex., 1399; Trinity River, Tex., 1401; Cedar Bayou, Tex., 1405; Buffalo Bayou, Tex., 1409; harbor at Brazos Santiago, Tex., 1413.

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REPORT OF CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

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REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS.

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REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mississippi River above Falls of St. Anthony, Minn., 1693; reservoirs at headwaters of Mississippi River, 1696; Chippewa River, including Yellow Banks, Wis., 1718; St. Croix River, Wis. and Minn., 1721; Minnesota River, Minn., 1725; Red River of the North, Minn. and N. Dak., 1728; gauging Mississippi River at or near St. Paul, Minn., 1732; surveys for reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers, 1736.

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REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

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REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Obion River, Tenn., 1785; Tennessee River above Chattanooga and below Bee Tree Shoals, 1787; Hiwassee River, Tenn., 1795; French Broad and Little Pigeon rivers, Tenn., 1797; Clinch River, Tenn., 1801; Cumberland River, Tenn. and Ky., 1804; Caney Fork River, Tenn., 1818.

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REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala., 1821; operating and care of Muscle Shoals Canal, Tennessee River, 1828.

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REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ohio River, 1836; operating snag boat on Ohio River, 1864; operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa., 1867; movable dam in Ohio River below mouth of Beaver River, Pa., 1870; ice harbor at mouth of Muskingum River, Ohio, 1874; Muskingum River, Ohio, 1875; operating and care of locks and dams on Muskingum River, Ohio, 1876; removing sunken vessels or craft obstructing or endangering navigation, 1889.
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REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monongahela River, W. Va. and Pa., 1903; operating and care of locks and dams Nos. 8 and 9, Monongahela River, 1908; purchase of Lock and Dam No. 7, Monongahela River, purchase of Lock and Dam No. 6, Monongahela River, Cheat River, W. Va., 1911; Allegheny River, Pa., 1913; dam at Herr Island, Allegheny River, near Pittsburg, Pa., 1918.

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REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River at Louisville, Ky., 1929; Indiana Chute, Falls of the Ohio River, 1933; operating and care of Louisville and Portland Canal, Ky., 1935; Wabash River, Ind. and Ill., 1942; White River, Ind., 1948.

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REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Great Kanawha River, W. Va., 1951; operating and care of locks and dams on Great Kanawha River, W. Va., 1962; Elk River, W. Va., 1963; Gauley River, W. Va., 1964; New River, Va. and W. Va., 1965.

APPENDIX H H.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tradewater River, Ky., 1967; reconstruction of Lock No. 2, Green River, at Rumsey, Ky., 1968; Green River, above mouth of Big Barren River, Ky. (Lock No. 5), 1971; operating and care of locks and dams on Green and Barren rivers, Ky., 1972; Rough River, Ky., 1978; Kentucky River, Ky., 1980; operating and care of locks and dams on Kentucky River, Ky., 1983; Licking River, between Farmers and West Liberty, Ky., Big Sandy River, W. Va. and Ky., 1992; Levisa Fork of Big Sandy River, Ky., 2001; Tug Fork of Big Sandy River, W. Va. and Ky., 2002; Guyandotte River, W. Va., 2004; Little Kanawha River, W. Va., 2006; operating and care of lock on Little Kanawha River, W. Va., 2007.

PART IV.

APPENDIX I I.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Grand Marais, Minn., 2009; harbor at Agate Bay, Minn., 2011; harbor at Duluth, Minn., 2014; harbor at Superior Bay and St. Louis Bay, Wis., 2019; harbor at Ashland, Wis., 2023; harbor at Ontonagon, Mich., 2026; Eagle Harbor, Mich., 2028; waterway from Keweenaw Bay to Lake Superior, Mich., 2029; harbor at Marquette, Mich., 2035; harbor of refuge at Grand Marais, Mich., 2037.
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APPENDIX J J.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS.

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INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 30, 1894.

GENERAL: I have the honor to submit my annual report upon the improvement of South Pass of the Mississippi River for the fiscal year ending June 30, 1894.

But little work was done during the year relative to the maintenance of the constructions which constitute the jetties and auxiliary works, and consisted of slight repairs to them and to the plant used.

Thirty-two days' dredging was done to maintain the required channel; during thirty days of this time work was done in South Pass itself at localities 1½, 7, and 9 miles above South Pass Light-house.

During the year "a navigable depth of 26 feet" was maintained at the head of South Pass, and a channel "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width," through the jetties at the mouth of South Pass, were both maintained. In the Pass itself, however, there were 15 days during the year when "a navigable depth of 26 feet" was not maintained, as follows: 6 days at a locality 1⅜ miles below the head of the Passes Light-house, and 9 days at a locality 1½ miles above South Pass Light-house.

Herewith is the report of Mr. C. Donovan, assistant engineer, which, with accompanying charts, give all details relative to work done during the year, the present condition of the works, and of the channel, together with other information of interest and value.

Estimate of funds required for examinations and surveys at South Pass, Mississippi River, during the fiscal year ending June 30, 1896.

1 assistant engineer	$2,700
1 recorder	1,500
1 steam engineer	1,200
1 water-level observer	120
6 seamen	3,370
Rent of office	180
Rent of quarters for assistant engineers	240
Mileage and traveling expenses	175
Repairs to launch and boats	700
Supplies for launch and office	300
Contingencies	1,800
Total	12,285

Money statement.

July 1, 1893, balance unexpended	$1,852
Amount allotted under act of August 11, 1888	10,000
	11,852
June 30, 1894, amount expended during fiscal year	10,699
July 1, 1894, balance unexpended	1,152
July 1, 1894, outstanding liabilities	78
July 1, 1894, balance available	1,074
Amount allotted by act of August 11, 1888	10,000
Amount available for fiscal year ending June 30, 1895	11,074

Statement of expenditures on account of appropriation for "examinations and survey South Pass, Mississippi River," for the fiscal year ending June 30, 1894, made in c pliance with section 4 of river and harbor act of August 11, 1888.

Amount appropriated by act of August 11, 1888 ..... $10,000

EXPENDITURES.

1 assistant engineer, twelve months, at $200	$2,400
1 recorder, twelve months, at $100	1,200
1 engineer launch, twelve months, at $100	1,200
1 first-class seaman, twelve months, at $70	840
2 first-class seamen, twenty-four months, at $65	1,560
1 first-class seaman, twelve months, at $60	720
1 first-class seaman, seven days, at $2	14
1 water-level observer, twelve months, at $10	120
1 clerk, two months, at $125	250
Rent of office and quarters at Port Eads, La., twelve months, at $35	420
Traveling expenses	30
Stationery	47
Repairs to steam launch *General Reese*	876
Ship chandlery, hardware, etc	226
Telegrams	1
Coal	562
Tide gauges	231
Total expenditures	10,699

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., June 30, 189

SIR: I have the honor to submit my annual report for the fiscal year ending J 30, 1894, relative to the improvement of the South Pass of the Mississippi River, amount and character of the work done during the year, the present conditio the jetties and auxiliary works, and the effect of the same upon the channel wh they were designed to improve.

The work is still under the direction of Messrs. James F. How and Estill McHenry, of St. Louis, Mo., by authority granted them as the legal representatives of James B. Eads, deceased, in an act of Congress approved March 3, 1875.

The following charts accompany this report:

No. 1. Chart of the channel from South Pass Light-House, through the jetties, to deep water in the gulf.

No. 2. Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.

No. 3. Chart of a part of South Pass, from South Pass Light-House to Grand Bayou.

No. 4. Chart of a part of South Pass, from Grand Bayou to the Head of the Passes.

No. 5. Chart of the Head of the Passes.

No. 6. Plan and comparative profiles of South Pass.

No. 7. Diagrams showing changes in the gulf for each year from 1876 to 1893.

In consequence of the prosecution of work for the closure of Pass a Loutre Crevasse, which was deemed important in order to aid in the restoration of the normal volume of flow into South Pass, but little work was done during the year in connection with the maintenance of structures which constitute the jetties and auxiliary works for the improvement of South Pass.

AT THE HEAD OF THE PASSES.

West T-head.—This structure is more properly the west jetty at the head of South Pass. During the months of July, 1893, and April, 1894, some of the piles in it were renewed and willows and stone added to strengthen it in places. All the timber in this work will soon require renewal, as it is badly decayed, and, while the work presents an indifferent appearance, yet it is substantial, and the originial mattress foundation is permanently in place.

The following materials were used in the work: Forty-one piles, 255 cords of willows, 448 linear feet of 12 by 12 inch timber, 9 cubic yards of stone, 51 screw bolts, and 3 drift bolts.

Upper dam.—Three hundred and twenty-five feet of this dam is still in place, 25 feet of the east end having partially washed out during the year. Continuing to the eastward from the portion in place, there are 200 feet in length where some of the piling remain, and also some of the willow work, although the latter is below the surface. The portion in place is about 3 feet above the surface, the piles are badly decayed, and to permanently maintain it will require that considerable work be added to it. During the month of April 194 cords of willows, weighted with earth, were placed in this dam.

Mattress sills across Southwest Pass and Pass a Loutre.—No important change took place in connection with either of these sills during the year, and they remain substantially in the same condition as last reported.

The location of all works at the Head of the Passes is given on chart No. 5.

IN SOUTH PASS.

During the month of May four wing dams of sheet piling were built, projecting from the west shore of South Pass, just below the Head of the Passes Light-House. These were built for the purpose of arresting the scouring away of the west bank, by deflecting the current from it, and concentrating the flow so as to straighten the channel through this reach.

The location of these dams is given on chart No. 5, and the accompanying sketch on p. 1336 explains their construction.

From the name of the inventor, the construction is known as the Sewall sheet piling. It consists of rectangular piles 12 inches wide and 8 inches thick, to the edges of which are spiked pieces 2 inches thick and of such shape as to form a dovetail groove on one edge of the pile and a corresponding tongue on the other, and when driven they form a water-tight dam.

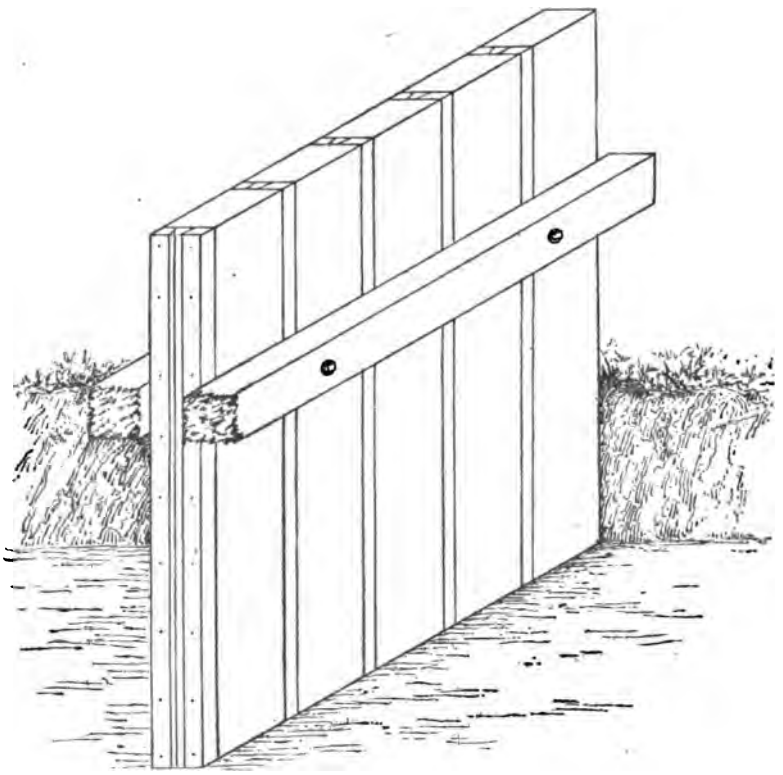
The piles are left about 7 feet out of water and are of such lengths as to give a penetration of about 15 feet. Their stability and rigidity is increased by two 8 by 8 inch waling pieces placed about 4 feet above the water, one on either side of the piles and opposite each other, and are held by bolts passing through them and the piles in the dam.

The advantage of being able to build these dams on a steep slope, and of getting them to a foundation below any possible scour, renders them preferable to, and they are more economical than, those which have hitherto been constructed of piles, willow, and stone.

The following table gives the materials used in these dams:

No.	Length.	Piles.	Linear feet of material.			Bolts, ¾ by 26 inches.	Kegs spikes, 5 and 7 inches.
			8 by 12 inches.	8 by 8 inches.	2 by 3 inches.		
	Feet.						
1	43	36	1,268	89	3,585	14	4
2	33.2	28	950	79	2,679	10	3
3	41.1	35	1,232	92	3,486	17	4
4	23.8	20	636	50	1,788	8	2

In Goat Island Reach.—Wing dams Nos. 1, 2, 5, and 10 were maintained by the addition of 102 cords of willows, 2 piles, and 2 screw bolts, and are in good condition.



In Grand Bayou Reach.—Three hundred and ninety-nine cords of willows, 11 piles, 182 linear feet of 12 by 12 inch timber, 46 cubic yards of stone, 21 screw bolts, and 9 drift bolts were placed in wing dams 3, 4, 6, 13, and 14. Such of these dams as are essential are maintained in a fair condition, but many of them having served the purpose for which they were built, and having induced a new bank formation, no longer require attention.

AT THE MOUTH OF SOUTH PASS.

East Jetty.—No work was done on this jetty during the year. Its condition is as follows: For 3,560 feet from its initial point it is buried by the land formation which has taken place since it was built, and as long as it remains in this condition its permanency is assured. The reef or coast line east of the jetty, which receded rapidly during some years past, remained practically unchanged during the year,

probably in consequence of the effect of the crib dams which were placed last year to arrest the eroding current along that shore.

For the next 400 feet the jetty remains as originally built, consisting of a row of sheet piling against which, and on the channel side, mattresses weighted with rock were placed. This portion is in good condition. Thence for 2,230 feet cribs of pine timber, filled with stone, were placed upon the original mattress and rock foundation, and while the latter is in good condition the former has proven to be but temporary, deteriorating rapidly, being eaten by the teredo in places, and is gradually being broken up, and while most of it is still in place its condition is inferior.

The remainder of this jetty is capped by a concrete wall built upon the original mattress foundation, and with the exception of 304 feet, in two sections, of older wall, and another of the newer wall where the foundation was undermined, causing the wall to settle, although it was not otherwise displaced, the work is in good condition, and effectually withstood the force of violent storms which visited the locality October 1 and November 26, 1893.

The average settlement of this wall during the year was 0. 14 foot, and since its completion in September, 1889, the average settlement has been 0. 63 foot.

Inner East Jetty.—During the month of May the force employed in closing Pass a Loutre Crevasse was temporarily withdrawn from that work, and are now employed in building up such portions of this jetty as require most attention. The general condition of this work is fair. Three hundred and twenty-five cords of willows, and 140 cubic yards of stone were placed in it during May and June.

West Jetty.—As will be seen by reference to chart No. 1, this jetty is permanently secured by sediment which from year to year has been deposited about and upon it. Two hundred and twenty feet of the outer end is 4 feet below the surface of the water, and has 2 feet of sand over it.

Inner West Jetty.—No work has been done on this jetty since July, 1893, when 271 cords of willows, 9 piles, and 19 cubic yards of stone were added to it. Over a distance of 300 feet from the outer end, and in the dam connecting this end with the main jetty, most of the crib work has settled so that it is about 4 feet below the surface. It is still in place, however, and will serve as a good foundation for future work. Otherwise the jetty is in fair condition.

WING DAMS.

Wing Dams Nos. 21 and 39 had 17 cords of willows, and 14 cubic yards of stone added to them during July, 1893, since which time nothing has been done to these structures.

Nos. 8, 11, 15, 30, 31, 32, 35, 36, 38, 39, and 45 are in good condition. All the others will require more or less repairing.

The locations of all works referred to at the mouth of South Pass are shown on chart No. 1.

REDGING.

During the year the dredge boat worked 32 days of 10 hours each, as follows: 19 days in Goat Island Reach at a locality 9 miles above South Pass Light House, 2 days at a locality 7 miles above, 9 days 1¼ miles above said light-house, and 2 days in the Gulf Channel, beyond the ends of the jetties.

THE PLANT.

The dredge boat was docked, generally overhauled, and some of her woodwork renewed. Repairs were made to a small launch, pile driver, and several barges.

THE FORCE EMPLOYED.

The force employed during the year, including officers and employes in every capacity, averaged 20 in number.

EXAMINATIONS AND SURVEYS.

The principal results of examinations and surveys made during the year, to determine the condition of and changes in the channel, will be found on the charts and in the tables which this report contains, and together with data obtained during previous years furnish information relative to the present condition of the channel from the Head of the Passes to the Gulf of Mexico, and the changes which have taken place in it from year to year since 1875.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5. The survey was made during the month of October while the river was low, and in comparison with a similar survey made one year previous, I find by using section G H that for 600 feet from the east shore there has no change during the year; thence for a distance of 3,000 feet a deepening varying from 2 to 7 feet took place; thence for 800 feet a shoaling averaging 2 feet, and from this point to the west shore but *little change* is noted.

Using section I J, I find no change for a distance of 300 feet from the east shor thence for 1,700 feet an average deepening of 7 feet; thence for 600 feet no chang thence for 2,500 feet alternate slight deepening and shoaling; thence to the we shore a deepening of 1 foot.

On line C D, I find practically no change down to a point opposite upper da thence to the mattress sill a deepening varying from 1 to 3 feet.

On the line A B, commencing at a point 2,200 feet above upper dam, thence t point opposite that dam the shoaling varies from 1 to 5 feet; thence downward in South Pass the shoaling averages about 5 feet.

On line E F a uniform deepening of 7 feet above the mattress sill and 4 feet belo it resulted during the year.

In Pass a Loutre, at the lower limit of this survey, the 26-foot curves moved the eastward 900 feet, and at the upper limit 300 feet, during the year, and the we shore receded 200 feet.

As soon as the river began to rise the channel into South Pass began to deep rapidly, and the shoal shown on chart 5, near to and below the east light, was so scoured away. The channel is now farther to the eastward, running close to t east light, and is deep, wide, and easy of navigation.

The required "navigable depth of 26 feet" was maintained at the Head of Sou Pass during the year without the aid of dredging.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

During the month of September, 1893, a complete survey of South Pass was mad the charts of which are Nos. 3 and 4. The following table compiled therefr gives the depth and width of channel in different reaches:

Tabulated statement of the depth and width of channel throughout South Pass of Mississippi River, from East Point to 30-foot depth in the main river, given in separ reaches one-fourth of a mile in length from a survey made in September, 1893.

Locality.		Available depth.	Available width of—	
From—	To above East Point.		26-foot channel.	30-foot channel.
East Point	¼ mile	28.8	220	(a)
Above East Point—				
¼ mile	½ mile	29.5	300	(b)
½ mile	¾ mile	31.7	310	180
¾ mile	1 mile	33.7	285	170
First mile		28.8	220	
1 mile	1¼ miles	31	320	140
1¼ miles	1½ miles	31	360	130
1½ miles	1¾ miles	30	420	240
1¾ miles	2 miles	31	420	240
Second mile		30	320	130
2 miles	2¼ miles	32	425	350
2¼ miles	2½ miles	34	420	350
2½ miles	2¾ miles	35	430	370
2¾ miles	3 miles	30.8	420	330
Third mile		30.8	420	330
3 miles	3¼ miles	30.8	320	100
3¼ miles	3½ miles	30	190	50
3½ miles	3¾ miles	27	200	(c)
3¾ miles	4 miles	31	320	70
Fourth mile		27	190	
4 miles	4¼ miles	30.4	330	180
4¼ miles	4½ miles	30.4	390	140
4½ miles	4¾ miles	31	450	250
4¾ miles	5 miles	33	290	170
Fifth mile		30.4	290	140
5 miles	5¼ miles	29.2	260	(d)
5¼ miles	5½ miles	27.4	360	(e)
5½ miles	5¾ miles	27.2	280	(f)
5¾ miles	6 miles	27.4	260	(g)
Sixth mile		27.2	260	

Locality.		Available depth.	Available width of—	
From—	To above East Point		26-foot channel.	30-foot channel.
Above East Point—				
6 miles	6¼ miles	28	370	
6¼ miles	6½ miles	27.3	390	
6½ miles	6¾ miles	29	390	
6¾ miles	7 miles	32.6	390	
Seventh mile		27.3	390	
7 miles	7¼ miles	31	460	
7¼ miles	7½ miles	33	430	
7½ miles	7¾ miles	35	340	
7¾ miles	8 miles	33.5	280	
Eighth mile		31	280	
8 miles	8¼ miles	27.8	220	
8¼ miles	8½ miles	28	210	
8½ miles	8¾ miles	31	170	
8¾ miles	9 miles	31.3	170	
Ninth mile		27.8	170	
9 miles	9¼ miles	30	210	
9¼ miles	9½ miles	27.2	180	
9½ miles	9¾ miles	31.5	360	
9¾ miles	10 miles	42	280	
Tenth mile		27.2	180	
10 miles	10¼ miles	27	270	
10¼ miles	10½ miles	31	240	
10½ miles	10¾ miles	31	210	
10¾ miles	11 miles	28	260	
Eleventh mile		27	210	
11 miles	11¼ miles	36	460	
11¼ miles	11½ miles	32	640	
11½ miles	11¾ miles	33	(*)	
11¾ miles	12 miles	35	(†)	
Twelfth mile		32	460	

* *Very wide.*

† In Mississippi River, above the Head of the Passes.

Length of the portion of this reach not having a central depth of 30 feet.

	Feet.		Feet.
(a)	130	(m)	230
(b)	140	(n)	580
(c)	1,000	(o)	140
(d)	150	(r)	1,100
(e)	1,320	(s)	660
(f)	1,320	(t)	160
(g)	1,320		
(h)	1,320	Total	10,890
(i)	1,320		

Referring to the comparative profiles on chart No. 7, it will be seen that, as a general result, the Pass shoaled an amount which averages about 2 feet. These profiles furnish detailed information relative to the changes which have taken place throughout the Pass during the year and since 1875.

From July 1 to July 6, 1893, both dates inclusive, the required "navigable depth of 26 feet" did not obtain in Goat Island Reach at a locality 1⅛ miles below the Head of the Passes Light-House. Also, at a locality 1½ miles above South Pass Light-House said required depth did not obtain from May 11 to May 19, both dates inclusive. There were, therefore, fifteen days during the year when a legal channel was not maintained.

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties and beyond them to deeper water in the gulf is given on chart No. 1.

The required channel, "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width," was maintained during the year.

From comparative profiles on Chart No. 7 and results given in the following table it will be known what changes have taken place in this channel during the year.

Tabulated statement relative to the available depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made during the fiscal year ending June 30, 1894.

Date.	Distances from East Point, in feet.								
	0 to 2,000.			2,000 to 4,000			4,000 to 6,000.		
	Available depth.	Available width of—		Available depth.	Available width of—		Available depth.	Available width of—	
		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.
1893.									
June	32.7	300	170	33	360	280	33.8	330	240
July	32	290	80	33.3	340	280	34	320	250
August	32	260	140	32	360	310	34	315	250
September	31.5	260	110	31.5	360	260	32.4	290	230
October	31.5	310	130	32.2	340	270	32.7	320	220
November	31.4	300	90	32.7	335	250	33.3	335	240
December	31	280	110	32	350	280	33	300	240
1894.									
January	32.1	340	100	32.1	350	245	33.5	340	240
February	30.6	265	130	32.2	360	240	32.6	290	230
March	32.8	260	115	31.8	350	250	31.7	310	190
April	34.3	270	160	31.4	365	210	32.7	320	140
May	32	240	150	32	360	300	34	340	240
June	32.2	250	145	31.2	350	260	32.9	310	150

Tabulated statement relative to the available depths and widths of channel through the jetties, etc.—Continued.

Date.	Distances from East Point, in feet.								
	6,000 to 8,000.			8,000 to 10,000.			10,000 to 12,000.		
	Available depth	Available width of—		Available depth.	Available width of—		Available depth.	Available width of—	
		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.		26-foot channel.	30-foot channel.
1893.									
June	36	260	210	31.7	260	120	30.5	270	120
July	35	265	195	36.7	265	190	35	290	185
August	34.5	265	190	35.3	270	190	34.2	290	180
September	33.5	250	170	35.3	260	160	31.8	275	150
October	33.2	250	190	34.2	260	155	33.2	270	150
November	32.8	260	200	34.3	280	160	33	280	150
December	33	250	190	34.8	260	160	33.5	265	150
1894.									
January	33.2	280	205	36	270	175	34.5	270	170
February	32.6	255	190	34.5	265	165	33	265	160
March	32	275	200	34.2	270	180	34	270	180
April	33	275	190	32.3	275	160	34	270	125
May	34	285	190	34	250	170	33	230	100
June	33	260	155	32.7	225	115	33.6	220	120

Beyond the ends of the jetties, and on a direct course therefrom, the required chan- was maintained during the year, and but two days' dredging was done.

The following table gives the depths through the jetties from month to month since 1875, and together with the profiles on Chart 7, constitute an interesting record of the improvement of this channel:

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875—June	22.5	18.7	16.7	10.2	9.7	9.2
1876—May	23.3	20.3	22	21	17.1	15
August	23.5	19.6	21	23.5	23	19.8
November	22	20.3	21.1	21.2	21.1	20.3
1877—March	24.1	21.1	23.2	22	21.2	20.5
July	24.9	24	26	23.8	23.5	20.3
October 25 to December 14	26.3	24.4	28.5	24.2	23	23.7
1878—March	26	25.9	35.5	25.4	24.3	23
December	28.4	26.4	35.7	27.1	25.3	23
1879—March	28.6	27.5	43.4	27	27	27
June	27.5	28.4	47.7	29.2	29.2	28
July 8	30.5	30.7	.....	31	30.7	30.5
December	31	31	48.3	31.7	31.8	30.8
1880—June	31	32.5	47.6	31.4	35.1	32
July	30.5	31	44	30.8	31.5	30.5
August	30.5	30.4	46	32	32	30.5
September	30.7	31	44.4	30.6	32	31
October	31	31.5	41	30.3	31	30.5
November	30.6	31	40.3	30.8	30.9	30.5
December	30.9	30.6	43	30.8	31	30.3
1881—January	30.5	30.4	41.9	33.8	30.7	30.3
February	30.4	30.2	41.6	32	31	30
March	31.5	31.2	41.3	32	32	30.5
April	30.4	30	43	33	33	30.5
May	30.2	30.5	42.7	32.6	30.5	31.2
June	30	30.5	43.8	32	31.7	31.7
July	31	32	42.5	33.5	33	32
August	30.1	32	37.6	32	31	30.2
October	30.2	30.3	38.3	31.4	31.2	30.3
November	30.8	31.8	39.2	30.4	30	30.1
December	30.2	32.8	39.4	30.8	30.2	30
1882—January	30.5	30.4	41.3	31.1	30.2	30.7
February	31.8	36	39.7	30.5	30.8	30.2
March	31.2	30.6	39.2	30.8	31.6	32.5
April	31.7	32.6	39.6	30.5	30.3	33
May	30.5	32.5	39.4	31	31.3	31

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1882—June	30.8	35.5	39	31.3	31.3	31
July	30	32.7	38.7	30.6	31.3	31.5
August	30.3	32.2	38.1	31.8	31.8	30.5
September	30.1	31.5	38.3	31.9	30.8	30.5
October	30	31	37.1	31	31.4	31.2
November	30	32	38.1	21.5	31.2	31.2
December	31	31	37	31.2	31	30.4
1883—January	31	31	35.2	30.2	30.1	30.1
February	31.2	31.2	36	30.5	30	30.1
March	32.3	32.6	45.7	31.5	30.3	30.3
April	33.7	35	44	32.2	30	39
May	33.2	36.3	46	32.3	30.3	32.4
June	32.5	34.2	45	33.4	31	33
July	33.8	34.9	44	32	31.5	31.8
August	32.1	38.2	48	33.4	33.4	32.2
September	33.4	34.3	46	32.3	32.3	30.6
October	32.7	34.1	41.5	32	32	30.5
November	31	33.8	43.8	34.5	31.5	31
December	30.5	32.6	43	31.6	31.6	30.2
1884—January	31.2	32.2	39.2	32.7	31.8	30.3
February	32	31.5	41.3	31.6	31	30.7
March	35.7	39.5	41.6	34	33.8	38.7
April	35.3	37.3	41.5	31.7	32.7	35.4
May	34.9	35.8	42.3	34.3	35.1	33
June	35	35.8	41.1	34	35	35
August	31.9	35.8	41.9	33.9	35	32
September	32	34	39	33.1	33.7	33.5
October	31.1	33.4	38.6	32.6	32.6	32.5
November	32.8	32.8	37.2	32.2	32.4	30.8
December	31.6	32.6	37.1	31.1	31.5	31.4
1885—January	36.7	36.4	36.9	33.1	34.6	32.8
February	41.7	36.3	35.7	30.5	34.1	36.2
March	35.5	36	36.1	31	31.7	35.7
April	36	35.5	37	32	32.6	32
May	36.7	35	35.6	31.5	33.5	31.5
June	34.7	33.7	35.7	32.8	32.8	31.3
July	36.3	33.1	36.5	33.7	33.6	31
August	36.5	35.6	37.6	33	32	31
September	35.3	33.3	35.2	32.2	30.7	31.7
October	33.8	33.7	35.8	31.3	30.4	30.4
November	32.7	32.8	35.1	30.8	30.6	30.1
December	33	32.2	34.2	30.9	30.5	30.6
1886—January	33.6	32.5	33	30.2	30.2	28.5
February	32.8	32.8	34.1	31.3	30.9	30
March	32.8	35.8	34	35	33.1	32
April	35.4	34.5	34.5	33.7	33.7	31
May	35.9	35.6	34.2	31	36	34.4
June	38.2	35.2	33.4	33.2	34.5	36.5
July	36.7	36.7	36.2	32.8	32.7	37
August	35	36	35.7	34.8	33.8	34.7
September	34.5	35.6	34.6	33.7	33.6	33
October	35	36.2	34.4	33	34.1	33
November	34.5	35.6	34.8	32.9	33	33.5
December	34	35	35.3	33.6	32.6	33
1887—January	33.6	34	33.3	32.3	32.7	33.4
February	36.4	34.4	35.4	31.3	34.1	32.4
March	35.5	35.5	32.6	35.5	35.5	33.8
April	38.8	37	33.7	31	34.8	35.5
May	39.4	35.3	37.1	31.2	34.2	38.1
June	39	35.4	37.5	32.3	34.1	35.2
July	39	36.4	35.8	34	32	34
August	35.7	34.6	34.7	33.6	31.6	32.7
September	36	34	35	35	32.7	32.2
October	36.2	34.2	34.3	32.1	32.2	31.8
November	35.9	32.9	33.8	30.7	31.8	31.2
December	34.7	32.7	33.9	30.9	31.7	31.8
1888—January	35.6	32.5	33.7	30.5	31.5	32.2
February	34.3	32.4	32.5	31	31	32
March	34	33	32.6	30.5	31.3	30.9
April	36.3	34.8	33.8	31	35	31.4
May	35.2	35.2	34.3	31.6	33.6	33
June	32	33	33	31.4	35.5	33.2
July	34.2	34	33.8	31	31.9	33.6
August	33.7	33.7	33.7	31.2	31.2	33.2
September	32.7	32.7	32.8	30.8	31	32
October	33.3	33.3	32.3	30.6	30.4	30.4
November	31.8	32.8	31.7	30.6	30.6	30.8
December	31.4	32.4	31.6	30.3	*29.2	30.7

*From Dec. 28, 1888, to Jan. 4, 1889, inclusive.

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distance from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1889—January	31	31.3	30.6	30.3	31	30.8
February	32.4	32.5	31.8	32.8	31	32.5
March	30.2	32.2	30.4	32.3	31.8	31.6
April	30.8	32.1	31.2	32.8	32.8	30.6
May	30.8	32	30.7	32.6	31.2	30.8
June	30.4	32.2	31.3	31.5	31	30.8
July	30.3	31	31	32.4	31.3	31
August	31.7	31.4	31.5	31.6	31.4	31
September	30.9	31.3	31.2	31	31.1	.....
October	31.6	31	31.2	31	31.7	*29.6
November	31	31.2	31.2	31	31.3	31.4
December	30.8	31	31.2	31	31.7	31.2
1890—January	30.8	30.8	31.2	30.6	31	31
February	31.7	30.7	31.5	32.6	34.4	33
March	36.4	33.2	34	34	34	33.6
April	33.4	36	35	35	38.7	34.5
May	32	34	34	36	39	34
June	32	33.5	33	34	39.8	35
July	32.4	33.4	34	34	39	37
August	32	33	33	32.7	35	34
September	30.5	31.4	33	33	35	33
October	32	31	31	30.5	34	32.8
November	30.6	31.2	30.6	30.6	34	33
December	31.5	31.2	30.7	30.7	32.3	33.5
1891—January	31	31	31.2	32.2	32.3	32.5
February	31.7	31	31.4	32.5	35.2	32.7
March	32	34.3	36.4	37.5	36	34.6
April	30.5	32	36.5	39	36.4	34.2
May	30.3	32	32	35	36	34
June	33	31.1	32	34.7	37	35
July	31.4	30.4	30.4	33.3	35.8	34.8
August	31	31	31	32.3	32.9	31.4
September	30.6	30.6	30.7	31	31.5	.....
October	31	30.8	30.8	31.2	31.2	30.7
November	31.2	31	31.3	31.2	31.1	30.6
December	30.1	30.3	30.6	31.4	31.3	32
1892—January	31.3	31.6	31.3	31.3	31.8	32.2
February	30.5	30.8	30.8	31	31.1	31.7
March	30.8	30,7	31.4	31.7	31.2	31
April	32	32	33.7	32	30.5	30.6
May	†28.1	§29.6	38	35	33	32
June	‡30.4	32.3	36	37	36.6	33.2
July	31.5	33	32	35.6	38	34.2
August	31.5	33.5	33.8	34.6	34.8	35
September	31.2	32.7	31.2	33.6	33.7	33.5
October	31.8	32.5	31.8	31.5	32.7	32.3
November	31.5	32.1	31.5	32	33	32.6
December	31	31.5	31.6	32.1	33.5	33.1
1893—January	31.6	32.2	31.3	32.1	32.2	34.1
February	31.6	31.6	31	31.6	32.7	34
March	33.6	34.6	33.1	30.8	31.2	32.4
April	33.6	35	33.6	31.6	32.3	32.6
May	32	34	33	33	32.5	32
June	32.7	33	33.8	36	31.7	30.5
July	32	33.3	34	35	36.7	35
August	32	32	34	34.5	35.3	34.2
September	31.5	31.5	32.4	33.5	35.3	31.8
October	31.5	32.2	32.7	33.2	34.2	33.2
November	31.4	32.7	33.3	32.8	34.3	33
December	31	32	33	33	34.8	33.5
1894—January	32.1	32.1	33.5	33.2	36	34.5
February	30.6	32.2	32.6	32.6	34.5	33
March	32.8	31.8	31.7	32	34.2	34
April	34.3	31.4	32.7	33	32.3	34
May	32	32	34	34	34	33
June	32.2	31.2	32.9	33	32.7	33.6

* From Oct. 1 to Oct. 5, inclusive.

† Depth less than 30 feet from Apr. 25 to May 6, both dates inclusive, and varied from 27.5 to 29.4 feet.

‡ Depth less than 30 feet from May 20 to June 20, both dates inclusive, and varied from 28.1 to 29.6 feet.

§ From Dec. 28 1888, to Jan. 4, 1889, inclusive.

SURVEY BEYOND THE ENDS OF THE JETTIES IN THE GULF OF MEXICO.

The chart of this survey is No. 2. The area sounded contains more than 2 square miles, the outer limit being the 100-foot curve, which is about 1¼ miles from the ends of the jetties.

A similar survey was made in May, 1892, and this being made in September, 1893, gives an intervening period of sixteen months, during which we get the effect of two high water periods.

Following the methods used for many years in deducing the results given on chart No. 7 and diagrams herewith, I find that from May, 1892, to September, 1893, all the curves advanced, the 30-foot curve showing the least advance of 135 feet, and the 100-foot curve the greatest, being 459 feet.

The following diagrams give the advance of each curve from 1877 to 1893, and from May, 1892, to September, 1893, and explain how great a percentage of the whole advance is that of the latter period.

Assuming that each mean ordinate in 1877 and 1892 be zero, then the length of the ordinate in 1893 measures the advance.

For example, from 1877 to 1893 the 20-foot curve advanced 964 feet, and from May, 1892, to September, 1893, it advanced 154 feet, etc.

It is evident from the foregoing, since all the curves have advanced, that a shoaling has taken place in the gulf beyond the ends of the jetties since 1876 and during the period from May, 1892, to September, 1893.

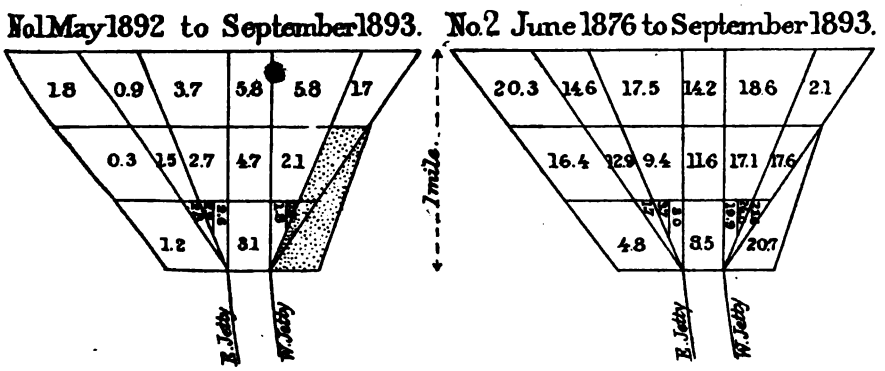
The vertical height of this shoaling over an area containing 1¼ square miles, and over each of 21 lesser areas into which it is subdivided, is determined by obtaining the mean depth of each subdivision and of the whole area and comparing it with previous results similarly obtained.

The results of these determinations are as follows:

Mean change over whole area.

From—	To—	Deepened.	Shoaled.	From—	To—	Deepened.	Shoaled.
		Feet.	*Feet.*			*Feet.*	*Feet.*
1876	1877	.....	0.40	1886	1887	.....	1.38
1877	1878	1.80	.....	1887	1888	.....	.31
1878	1879	.....	2.56	1888	1889	1.23	.....
1879	1880	.12	.....	1889	1890	.....	1.11
1880	1881	.....	2.38	1890	1891	.....	2.70
1881	1882	.....	1.30	1891	1892	.....	1.59
1882	1883	.04	.....	1892	1893	.....	2.11
1883	1884	.....	3.61				
1884	1885	1.16	.....	1876	1893	.....	15.22
1885	1886	.....	.12				

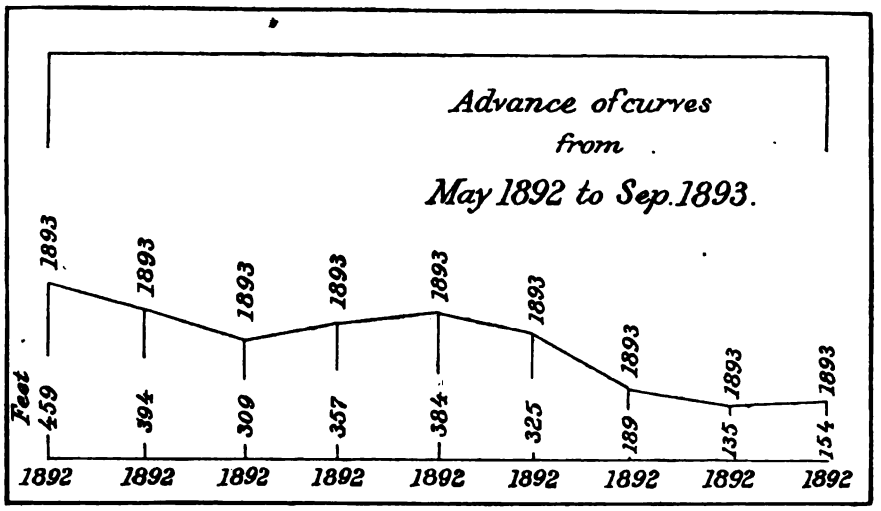
By the aid of the following diagrams which represent this area one may readily understand the distribution of the material deposited, and locate the areas of greatest and least change.

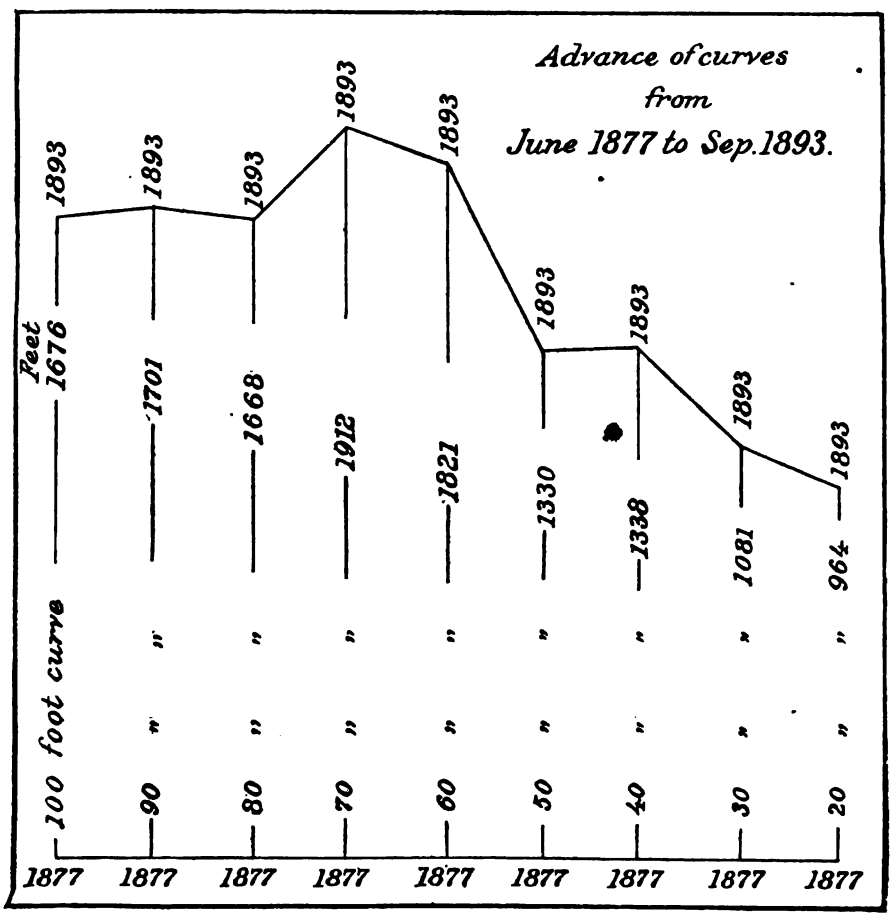


The figures in each area are the differences, in feet and tenths, between the mean depths obtained for the years between which comparisons are made, and denote the amount of shoaling or deepening in each.

No. 1 compares the mean depths in May, 1892, with those in September, 1893, and No. 2 compares those in 1876 with those in 1893. Shaded areas deepened.

The deepening in three areas, from 1892 to 1893, resulted from the effect of the storm of October 1, 1893.


Advance of curves
from
May 1892 to Sep. 1893.
Feet
459
394
309
357
384
325
189
135
154
1893
1892


Advance of curves
from
June 1877 to Sep. 1893.
Feet
1676
1701
1668
1912
1821
1330
1338
1081
964
100 foot curve
90
80
70
60
50
40
30
20
1893
1877

VELOCITY, SEDIMENT, AND DISCHARGE OBSERVATIONS.

For several years it has been apparent that the volume of discharge of South Pass has been decreasing, and in the absence of discharge observations, which would have been most desirable could they have been made without greatly increasing the force now employed, there has been compiled from our sediment, velocity, and tidal records the information contained in the following tables, which will be found of interest, and do not, I believe, require explanation, but will be readily understood.

Table giving data relative to South Pass of the Mississippi River, compiled from sediment and current observations, surveys, tidal data, Carrollton, La., gauge readings, etc.

Year.	Extreme height of river at Carrollton, La.	Ratio of—	
		Sediment to water (by weight).	Sand to water (by weight).
	Feet.		
1879	10.70	0.0004564	0.0001148
1880	14.25	.0008030	.0004725
1881	12.40	.0008255	.0003984
1882	14.95	.0006419	.0002543
1883	15.40	.0008166	.0003393
1884	15.50	.0005890	.0002834
1885	13.47	.0008768	.0002521
1886	13.80	.0005427	.0002473
1887	14.50	.0006410	.0002841
1888	14.05	.0010985	.0003743
1889	11.50	.0005211	.0002030
1890	16.10	.0005737	.0003060
1891	16.00	.0005806	.0003044
1892	17.20	.0007325	.0004684
1893	17.45	.0006206	.0003954

Year.	Base 1,306 feet above South Pass Light-House.			
	Area of base in square feet.	Discharge in cubic feet per second.		Velocity of current feet per second.
		Water and sediment.	Sediment.	
79	15,225.60	41,465.89	18.925	2.73
80	15,311	52,822.95	42.417	3.45
81	14,483.20	48,518.73	40.052	3.35
82	15,012.15	51,791.91	33.245	3.45
83	14,304,90	47,349.22	38.192	3.31
84	14,235.12	47,687.65	28.088	3.35
85	15,986.94	54,035.86	47.379	3.38
86	15,729.40	50,334.08	27.316	3.20
87	15,571.80	43,756.76	28.048	2.81
88	15,666.75	49,350.26	54.211	3.15
89	14,602.32	42,200.70	21.991	2.89
90	14,565.60	46,609.92	26.740	3.20
91	13,857	38,799.60	22.527	2.80
92	14,359.40	44,226.95	27.447	3.08
93	14,260	39,642.80	24.602	2.78

Year.	Slope of South Pass.	Mean depth of base.	Mean height of river at Carrollton, La.
	Feet.	*Feet.*	*Feet.*
79	1.05	24.96	4.682
80	1.27	25.10	7.376
81	1.29	23.36	7.308
82	.....	24.41	.....
83	1.24	23.26	8.920
84	1.27	23.26	8.232
85	1.06	26.08	7.210
86	.99	25.37	6.648
87	.99	25.32	4.977
88	.89	24.75	6.199
89	.68	23.86	6.018
90	.95	23.80	8.127
91	.78	22.35	7.092
92	.97	23.54	7.940
93	.81	23	7.239

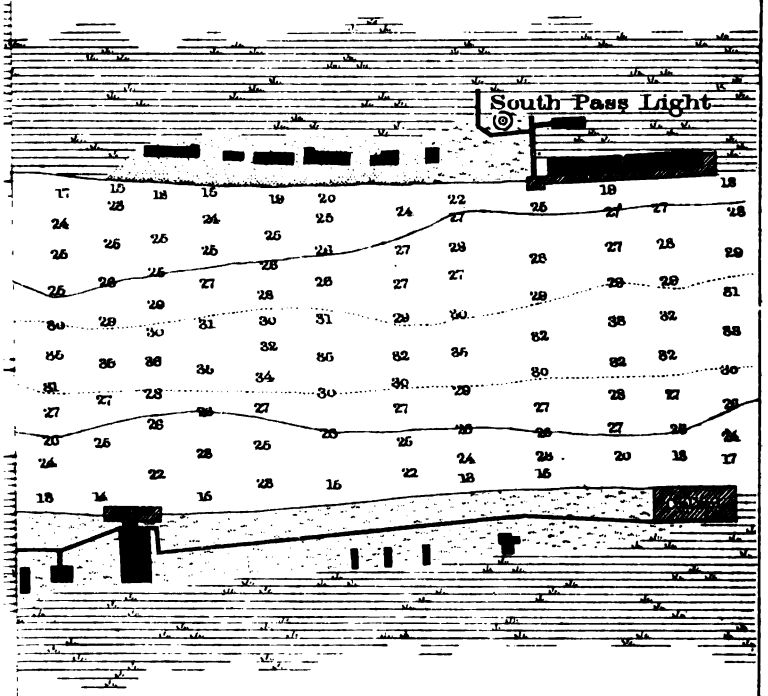
Yearly mean elevation of the water surface at high, low, and mean tide at t Passes and Port Eads, La., together with the slope of South Pass, mean current of South Pass, and Carrollton, La., gauge data from 1877 to 1893 inclusive.

Year.	Head of Passes.			Port Eads, La.			Slope of S	
	High tide.	Low tide.	Mean.	High tide.	Low tide.	Mean.	High tide.	L ti
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*F*
1877	2.436	1.542	1.989	2.741	1.586	2.163	0.975	1
1878	[1] 2.994	[1] 2.291	[1] 2.642	3.056	1.892	2.474	.....	...
1879	2.537	1.725	2.131	2.961	1.763	2.362	0.856	1
1880	2.958	[2] 2.165	2.561	3.157	1.979	2.568	1.081	1
1881	2.972	2.195	2.583	3.147	2.003	2.575	1.105	1
1882	.....	.....	.....	.....	.....	.....	.....	...
1883	[3] 3.223	[3] 2.516	[3] 2.869	3.349	2.331	2.840	1.091	1
1884	3.191	2.455	2.823	3.358	2.304	2.831	1.112	1
1885	2.986	2.214	2.600	3.339	2.291	2.815	.927	1
1886	2.848	2.063	2.455	3.275	2.222	2.748	.852	1
1887	2.632	1.785	2.208	[5] 3.059	[5] 1.944	[5] 2.501	[5] .853	[5] 1
1888	2.961	2.188	2.574	3.525	2.391	2.958	.716	1
1889	[4] 2.828	[4] 1.958	[4] 2.393	3.545	2.381	2.963	.532	
1890	3.466	2.701	3.083	4.001	2.826	3.413	.745	1
1891	3.298	2.331	2.814	3.951	2.673	3.312	.627	
1892	3.479	2.632	3.055	4.011	2.716	3.363	.748	1
1893	3.330	2.360	2.845	3.990	2.650	3.320	.621	

Year.	Mean velocity of current in feet per sec.	Carrollton, La	
		1	2
		Feet.	*Fe*
1877	.....	5.178	11.
1878	.....	6.546	10.
1879	2.73	4.682	10.
1880	3.45	7.376	13.
1881	3.35	7.308	12.
1882	.....	.....	14.
1883	3.31	8.920	14.
1884	3.35	8.282	15.
1885	3.38	7.210	12.
1886	3.20	6.648	13.
1887	2.81	4.977	11.
1888	3.15	6.190	12.
1889	2.89	6.038	10.
1890	3.20	8.127	15.
1891	2.80	7.092	14.
1892	3.08	7.940	16.
1893	2.78	7.239	15.

[1] No record for 5 lunations.
[2] No record for 1 lunation.
[3] No record for 3 lunations.
[4] No record for 1 lunation.
[5] Interpolated.
[6] Column 1 is the mean reading of the gauge for the year. Column 2 is the mean read for a lunation showing highest mean. Column 3 is the extreme height of the river for th

Through the courtesy of Mr. J. A. Ubsdell, manager of the estate o Eads, I was enabled to obtain the necessary assistance to enable me, mo ically, to make determinations of the volume discharged by each of the t with such frequency as my other duties would permit, and, weather per such times when all conditions were most favorable to obtaining acc



mpany annual report for the year ending June 30, 1894.

James A. Ludlow

Major, Corps of Engrs. U.S.A.

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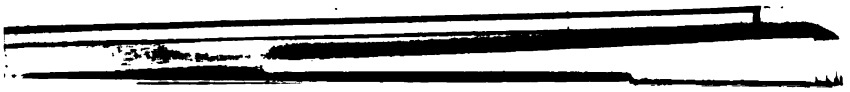

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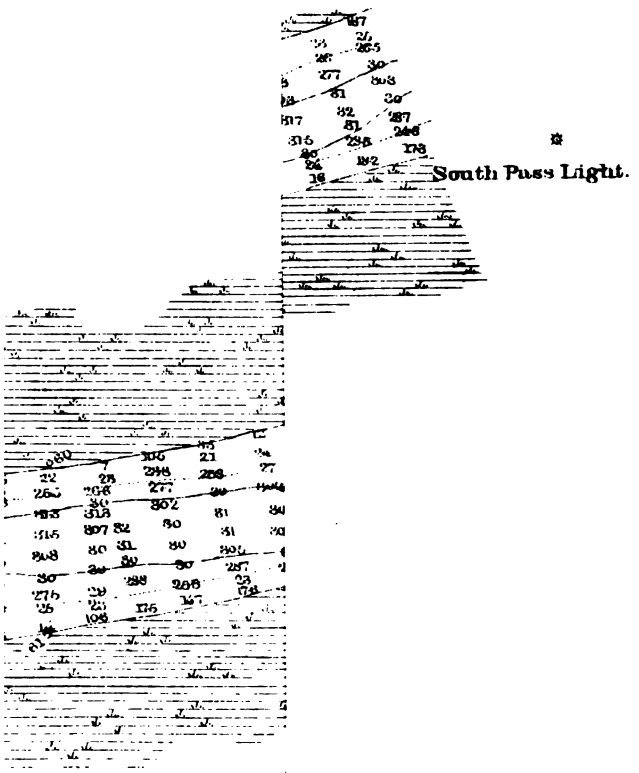
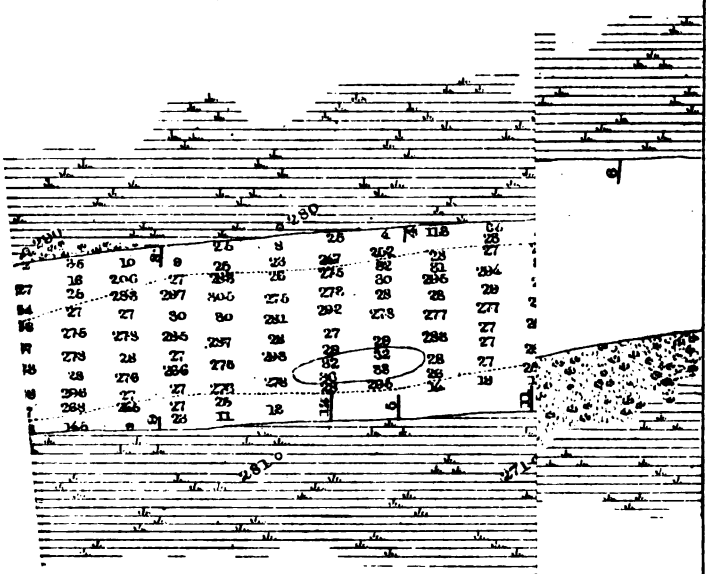


ting June 30, 1894.

N. Lima

Major, Corps of Engrs. U.S.A.

Eng. 53 3.



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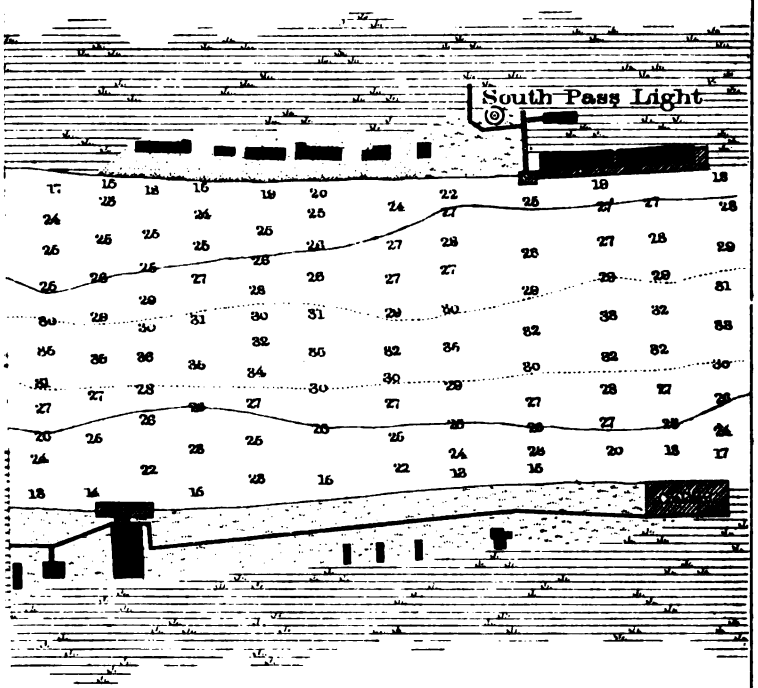
of Eng'rs. U. S. A.

No. Eng. 58 S.

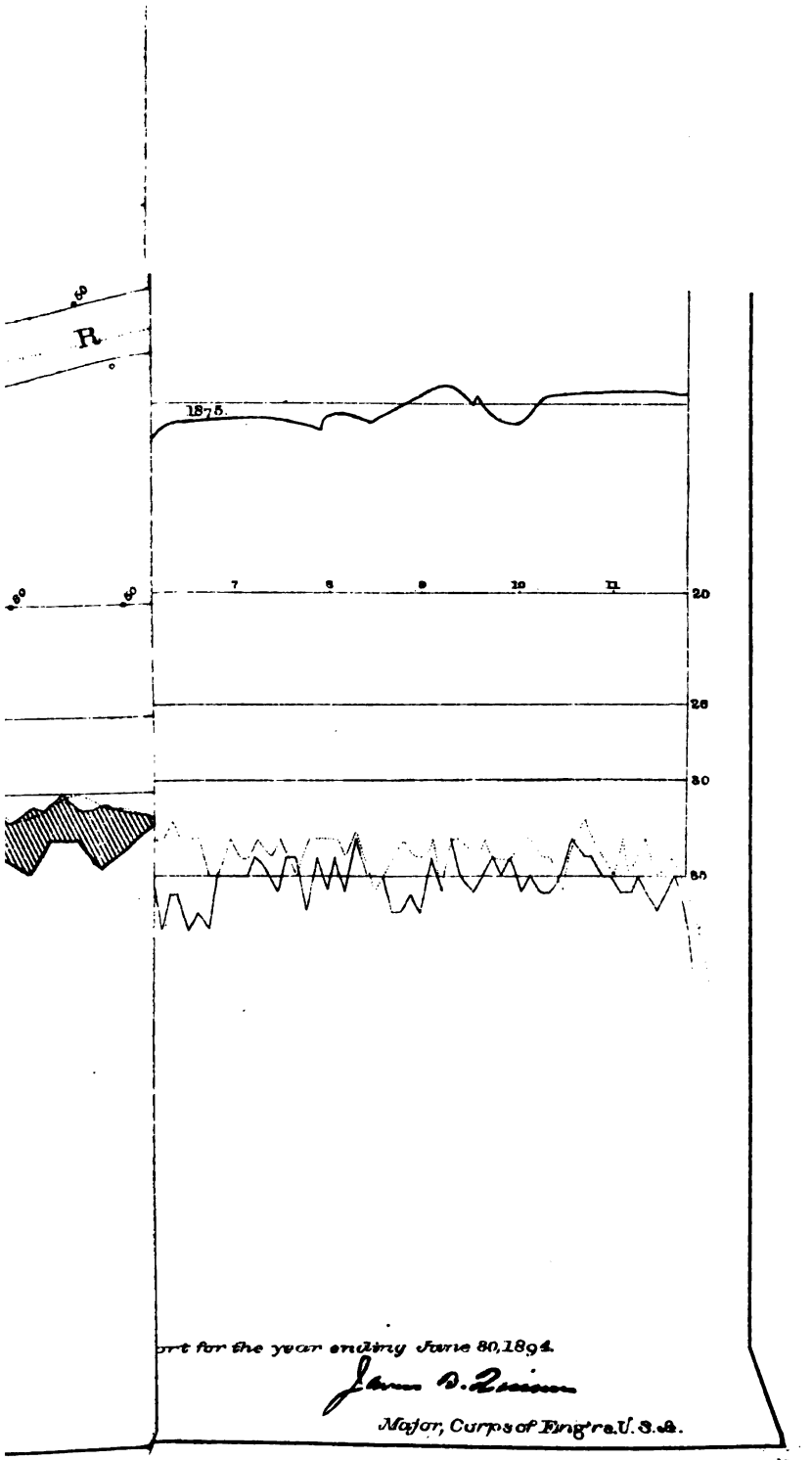


mpany annual report for the year ending June 30, 1894.

James A. Ames

Major, Corps of Engrs. U. S. A.

The Friedenwald Co. Photo-Lith. Balto., Md. Eng. 58 8.

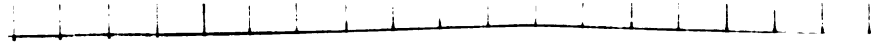


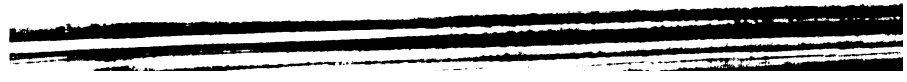
...rt for the year ending June 30, 1894.

James D. Lacey

Major, Corps of Eng'rs, U. S. A.

THE FRIEDENWALD CO. PHOTO-LITH., BALTO., MD. Eng. 53 8.





The following table gives the results of these and earlier determinations:

Volume of water discharged by each of the passes of the Mississippi River, the percentage of discharge of each to the other, and of each to the total discharge.

Date.	Discharge in cubic feet per second of—				Per cent of total discharged by—			Per cent of South Pass to—	
	South Pass.	South-west Pass.	Pass a Loutre.	Total.	South Pass.	South-west Pass.	Pass a Loutre.	South-west Pass.	Pass a Loutre.
1877—May 21	68,388	276,280	292,387	637,055	11	43	46	25	23
May 22	71,255	277,450	292,224	640,929	11	43	46	26	24
September 10	26,688	125,898	119,669	272,255	10	46	44	21	22
1878—June 8	61,562	245,501	264,823	571,886	11	43	46	25	23
1879—December 19	37,894	166,895	167,823	372,612	10	45	45	22	23
1880—January 30	68,181	281,793	290,699	640,673	11	44	45	24	23
April 21	78,410	327,916	367,199	773,525	10	42	48	24	21
July 24	52,172	224,343	223,946	500,461	10	45	45	23	23
1881—June 4	63,602	277,599	307,947	649,148	10	43	47	23	21
1894—March 21	56,221	323,782	339,185	719,188	8	45	47	17	17
April 17	56,317	316,906	380,086	753,309	8	42	50	18	15
May 2	53,058	292,835	411,390	757,283	7	39	54	18	13
May 15	46,718	243,261	311,426	601,405	8	40	52	19	15

Date.	Per cent of Southwest Pass to Pass a Loutre.	Stage of river at Carrollton, La.
1877—May 21	95	10.8, stationary.
May 22	95	10.9, stationary.
September 10	105	.4, rising.
1878—June 8	93	10.7, rising.
1879—December 19	94	3.2, rising.
1880—January 30	97	11.8, top of rise.
April 21	89	14.2, top of rise.
July 24	100	9, stationary.
1881—June 4	90	12.2, stationary.
1894—March 21	97	12.3, rising.
April 17	83	12.5, falling slowly.
May 2	71	12.6, falling slowly.
May 15	78	10.6, stationary.

VESSELS AGROUND.

From August 1, 1893, up to the present time (June 20) I reported to you the grounding of 10 steamers, 4 at the head of South Pass, 2 in Goat Island Reach, 1 7 miles above South Pass Light-House, and which afterwards grounded 1 1½ miles above said light, and 3 beyond the ends of the jetties.

Three of the vessels were of light draft, and grounded while attempting to enter the jetties in a dense fog. With but one exception, in the other 7 cases the grounding could not be attributed to the lack of a sufficient depth of water, and in that case the channel had been previously reported as lacking the required depth, and for nine days it was lumpy and not easily navigable for the deepest vessels.

The greatest delay to any vessel because of having grounded was in the case of the S. S. *Miguel Jover*—she was delayed 6½ days.

CONCLUSION.

In conclusion, I take pleasure in commending Mr. G. W. Laws, recorder, for faithful and valuable assistance rendered during the year.

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engineer.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

APPENDIX S.

IMPROVEMENT OF RIVERS AND HARBORS IN SOUTHERN LOUISIANA AND EASTERN TEXAS.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chefuncte River and Bogue Falia, Louisiana.
2. Tickfaw River and its tributaries, Louisiana.
3. Amite River and Bayou Manchac, Louisiana.
4. Bayou Lafourche, Louisiana.
5. Bayou Terrebonne, Louisiana.
6. Bayou Plaquemine, Grand River, and Pigeon bayous, Louisiana.
7. Bayou Courtableau, Louisiana.
8. Bayou Teche, Louisiana.
9. Channel, bay, and passes of Bayou Vermillion, Louisiana.
10. Mermentau River and tributaries, Louisiana.
11. Mouth and passes of Calcasieu River, Louisiana.
12. Harbor of Sabine Pass, Tex.
13. Sabine River, Texas.
14. Neches River, Texas.
15. Removing sunken vessels or craft obstructing or endangering navigation.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 7, 1894.

GENERAL: I have the honor to transmit herewith annual reports * * * upon works of river and harbor improvement at present under my charge for the fiscal year ending June 30, 1894.

* * * * * * *

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

S 1.

IMPROVEMENT OF CHEFUNCTE (TCHEFUNCTE) RIVER AND BOGUE FALIA, LOUISIANA.

The project for the improvement of this river was adopted in 1880 and contemplated the removal of obstructions in the channel, such as snags, logs, and overhanging trees, and the dredging of the bar at the river's mouth.

With the two appropriations made in 1881 and 1882 of $1,500 each, the obstructions below Covington were removed, and part of the unexpended balance was used for the construction of a working plant for improving the bar at the mouth and part of the construction of 820 feet of breakwater.

August 5, 1886, Congress made an appropriation of $2,500 for this work, and in 1887 channels were cut through the bars between Covington and Old Landing 5 feet deep and 30 to 60 feet wide, giving better navigation for schooners between these places.

The original estimated cost of improving this river was $5,460, the greater portion of which was for dredging the bar at its mouth.

It was thought, however, that a dredged channel over this bar could not be maintained without protecting works, which would cost considerably more than the dredging. Major Stickney, who had charge of this work, caused a reexamination to be made in 1884, and in his report in the Annual Report of the Chief of Engineers for 1884, Vol. 2, p. 1269, he reports the river in good order, except the bar at its mouth, and suggests as a method of improving this to build a jetty or breakwater 2,500 feet long across the bar into the comparatively deep water of Lake Pontchartrain, and then to dredge the channel through the bar, in the hope that the jetty would prevent, or at all events greatly retard, the refilling of the cut with sand.

Under the appropriation of $1,000 made September 19, 1890, the work of removing obstructions in the channel was commenced in October, 1891, using the snagging plant which had shortly before ceased operations on the Tickfaw River. This plant consists of a quarter boat, for the accommodation of the working party, and a flat supplied with a derrick and steam-hoisting engine for lifting out snags, and small boats, tools, etc, ordinarily used for this class of work.

Snags, logs, and impending trees were removed from the channel of the river from Madisonville to Old Landing, and from the latter place to Covington, on the Bogue Falia, as far as the funds on hand would permit. The principal obstructions removed from the channel during that year were: 161 snags, 82 overhanging trees, 61 landslide trees, 58 stumps, 44 logs, and 29 tree tops. The work was discontinued November 30, 1891.

In 1892 Congress appropriated $1,000 for maintenance. Aside from making extensive repairs to the snagging plant used on the improvement of these streams, no work has been done since then.

The total amount expended on the improvement to June 30, 1894, was $6,965.39.

The river now has a navigable depth of 5 feet to Old Landing, and from there to Covington the Bogue Falia is navigable for the lighter-draft schooners.

About $1,000 will be required each year to keep the river and bayou free of obstructions.

Abstract of appropriations for improving Chefuncte (Tchefuncte) River and Bogue Falia, Louisiana.

By act of Congress—	
Approved March 3, 1881	$1,500
Passed August 2, 1882	1,500
By act of Congress approved—	
August 5, 1886	2,500
September 19, 1890	1,000
July 13, 1892	1,000
Total	7,500

Money statement.

July 1, 1893, balance unexpended	$741.26
June 30, 1894, amount expended during fiscal year	206.65
July 1, 1894, balance unexpended	534.61
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	1,000.00

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	12
Trips made	637
Gross tonnage, registered	414,687
Schooners	42
Trips made	287
Gross tonnage, registered	246,820
Barges	6
Trips made	75
Gross tonnage	9,400
Total vessels	62
Total trips	999
Total tonnage	670,907

Draft of heaviest vessel, light, 5.6 feet; loaded, 7.2 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Lumber, shingles, and laths	8,314	$120,206	218,132	$462,838
Brick	4,405	16,571	8,750	28,000
Sand	11,776	15,702	6,870	9,160
Wood	234	410	536	1,206
Cotton	219	38,770	480	66,990
Rice	1,103	27,496	761	23,472
Miscellaneous	100	5,000	120	3,270
Sheep, cattle, and horses	101	7,386	426	11,000
Tar and rosin	124	2,730	125	1,368
Sirup	138	4,631	115	3,795
Pecans	8	1,488	4	600
Moss	8	296	6	240
Wool	4	940	3½	960
Total	26,534	241,626	236,328½	612,899
RECEIPTS.				
Merchandise	3,750	187,500	6,136	306,800
Grand total	30,284	429,126	242,464½	919,699

Comparative statement of receipts and shipments for five years.

Year ending May 31—	Tons.	Value.
1890	27,803	$173,283
1891	45,521	201,061
1892	50,054	354,684
1893	30,284	429,126
1894	242,464½	919,699

Chefuncte River *is navigated a distance of* 12 miles.

At two places, one-fourth and one-half miles, respectively, below Covington the river shoals to 4 feet and vessels are obliged to lighten their loads one-half in order to reach Covington, the main shipping point. If these shoals were dredged, not only would the expense and time in lighterage to shippers and carriers be avoided, but much of the freight now sent by railroad at higher rates of transportation would be shipped by vessel. On account of these two bars the large steamer making daily trips between the Chefuncte River and New Orleans can not reach Covington, the commerce of the upper portion of the river having to be done by schooners which draw 6 feet when loaded.

S 2.

IMPROVEMENT OF TICKFAW RIVER AND ITS TRIBUTARIES, LOUISIANA.

This work was commenced in 1879 by an examination authorized by Congress. The estimated cost of the improvement was $10,230, and the project was to clean out this stream, as well as its navigable tributaries, the Natalbany, Blood, and Pontchatoula rivers, by removing obstructions to navigation, such as snags, logs, stumps, and overhanging trees.

In 1881 $2,000 was appropriated with which to commence work. The work under this appropriation was done by contract in 1882, and 16 miles of the Tickfaw was cleaned out.

In 1882 Congress appropriated $2,000 more. This was expended partly in building plant, and the work of cleaning out the stream was done with this plant and hired labor. The result was a good navigable channel 9 miles above the previous head of navigation on the Tickfaw.

In 1886 an appropriation of $2,000 was made, the funds to be used for cleaning out the navigable branches of the Tickfaw. In the latter part of 1886 and early part of 1887 work was resumed with the Government plant and hired labor and the branches cleaned to the head of navigation.

In 1888 an appropriation of $1,000 was made for improving the Tickfaw and its navigable tributaries. The latter being in good condition, the snagging plant commenced work on the river itself in May, 1889, removing the obstructions that had re-formed since 1887, and worked up stream to within 1 mile of the Chapman Place, where operations ceased.

In 1890, $1,000 was appropriated for continuing the improvement. In September, 1891, work was commenced with the Government snagging plant and hired labor. The obstructions which had reformed since 1889, such as snags, logs, overhanging trees, etc., were removed from the Tickfaw, Natalbany, and Blood rivers, the latter being cleared to the head of navigation. About 39 miles of channel had been improved when the work ceased October 12, 1891.

On July 13, 1892, an appropriation of $1,000 was made for maintenance. The plant, which had shortly before been used on the Amite River, was towed to the Tickfaw, and work was commenced at the mouth of the river on December 20, 1892, and was carried on upstream, resulting in the improvement of 30 miles of channel by the removal of 120 logs, 96 snags, 89 overhanging trees, and 63 landslide trees, and the deadening of 14 trees. Operations were discontined January 20, 1893, and the plant was laid up at Springfield, La., and placed in charge of a watchman.

Extensive repairs to the snagging plant were completed in November, 1892. This plant consists of a quarter boat for the working crew,

a flat supplied with a derrick, and steam-hoisting engine for pulling out snags, and small boats, tools, etc., ordinarily used for this kind of work.

No work was done during the year ending June 30, 1894.

The improvement is not permanent, as obstructions continue to form in the channel which require removal from time to time. It is estimated that $1,000 will be required annually to keep the navigable channel in condition.

The total amount expended on the improvement of these streams to June 30, 1894, was $8,826.30.

Abstract of appropriations for improving Tickfaw River and its tributaries, Louisiana.

By act of Congress—	
Approved March 3, 1881	$2,000
Passed August 2, 1882	2,000
Approved August 5, 1886	2,000
Of August 11, 1888	1,000
Approved September 19, 1890	1,000
Approved July 13, 1892	1,000
Total	9,000

Money statement.

July 1, 1893, balance unexpended	$203.70
June 30, 1894, amount expended during fiscal year	30.00
July 1, 1894, balance unexpended	173.70
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	1,000.00

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	6
Trips made	138
Gross tonnage, registered	68,448
Schooners	33
Trips made	126
Gross tonnage, registered	87,066
Total vessels	39
Total trips	264
Total tonnage	155,514

Draft of heaviest steamer, 6 feet. Draft of largest schooner, light, 3.5 feet; loaded, 6.4 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Wood	3,748	$5,355	2,452	$6,908
Lumber	8,314	113,020	33,370	120,899
Brick	845	4,573	711	2,212
Cotton	53	6,857	155	21,630
Miscellaneous	34	1,701	45	2,025
Total	12,994	131,506	36,733	153,674
RECEIPTS.				
Merchandise	1,000	38,137	3,270	98,100
Grand total	13,994	169,643	40,003	251,774
Increase over *previous year*			26,009	82,131

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1892	11,407	$102,118
1893	13,994	169,643
1894	40,003	251,774

There is sufficient depth of water in the river for navigation, but the larger vessels can not carry full loads on account of snags, overhanging trees, and other like obstructions.

S 3.

IMPROVEMENT OF AMITE RIVER AND BAYOU MANCHAC, LOUISIANA.

The original project for the improvement of this river was adopted in 1880, which contemplated a channel 5 feet in depth as far upstream as appropriations would permit, the main part of the work to be done above the mouth of the Bayou Manchac.

In 1883, owing to the unsatisfactory manner of doing the work by contract, the project was amended so as to provide for the removal of obstructions below the Manchac by the Government plant and hired labor, and resulted in a satisfactory improvement of about 8 miles of the river.

In 1886, under an appropriation of $2,000, work with Government plant and hired labor was resumed, and the logs and snags removed from about 5 miles of river below the mouth of the Bayou Manchac, leaving the Amite River in good navigable condition.

In 1888 $5,000 was appropriated, with the stipulation that half of this sum might be used in improving Bayou Manchac, and in November, 1888, work with the Government plant and hired labor was commenced in this bayou, working up from its mouth to Hereford Landing, leaving the Manchac in good condition up to that point. The plant was then taken back to the Amite River, and from it removed the snags, logs, and impending trees which obstructed the channel.

In 1890 $3,800 was appropriated for the completion of the old project, the money, however, to be applied to the Amite or Manchac in such proportions as the engineers might deem best. Work was resumed in October, 1890, with the Government plant at Hope Villa, on the Manchac, and the bayou cleaned up for a distance of about 3 miles, when the plant turned back, and commencing at Wards Creek worked downstream to the Amite River.

Snags, logs, and impending trees were removed from the Bayou Manchac between its mouth and Hope Villa, and from the river between its mouth and the junction with Bayou Manchac.

In 1892 $2,500 was appropriated for maintenance, $1,000 of which is to be used to construct a turning basin for boats at or near the mouth of Wards Creek on Bayou Manchac. As the dredging of a turning basin at this place would cost more than the sum stated, my recommendation that this amount be held for further increase was approved.

Authority was obtained for repairing the snagging plant. The derrick and quarter boats were hauled out on ways and supplied with new decks, ends, and roofs, with sheet planking on the sides, and the hulls thoroughly calked. The repairs were completed in November, 1892, *and preparation made* for resuming operations. This plant consists of

a quarter boat for the working party, a derrick boat with steam hoisting engine for removing obstructions, and small boats, tools, etc., ordinarily used for this class of work.

Work was commenced November 17, 1892, under the appropriation of that year, at Wards Creek on Bayou Manchac, and was carried on to Port Vincent on the Amite River, improving about 20 miles of channel by the removal of 57 snags, 57 floating and sunken logs, 36 stumps, 29 overhanging trees, 28 sunken trees, and 9 clusters of brush, and the deadening of 165 trees. The work was discontinued December 15, 1892, and the plant towed to the Tickfaw River for work on that stream.

Stumps and logs are continually getting into the channel, forming snags and obstructions, and therefore the improvement is not permanent. About $2,500 will be required annually to keep these streams in navigable condition. About $2,000 will be required, in addition to the $1,000 now available, for constructing the turning basin for boats at or near the mouth of Wards Creek on Bayou Manchac.

No work was done last year.

The amount expended on the improvement of these streams to June 30, 1894, was $25,089.

Abstract of appropriations for improving Amite River and Bayou Manchac, Louisiana.

By act of Congress approved—	
June 14, 1880	$8,000
March 3, 1881	5,000
August 5, 1886	2,000
By act of Congress of August 11, 1888	5,000
By act of Congress approved—	
September 19, 1890	3,800
July 13, 1892	2,500
Total	26,300

Money statement.

July 1, 1893, balance unexpended	$1,256.00
June 30, 1894, amount expended during fiscal year	45.00
July 1, 1894, balance unexpended	1,211.00
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	4,500.00

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	12
Net tonnage, registered	319
Trips made	722
Total gross tonnage for 722 trips	230,408
Schooners	24
Net tonnage, registered	475
Trips made	51
Gross tonnage for 51 trips	24,225
Barges	2
Net tonnage	53
Trips made	136
Total gross tonnage for 136 trips	7,208
Total vessels	38
Total trips	506
Total tonnage of all vessels for total trips	261,841

Draft of heaviest steamer, light, 6½ feet; loaded, 7 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Lumber, shingles, and laths	10,567	$86,127	139,427	$418,947
Wood	4,406	5,910	4,018	8,376
Staves	261	1,229	448	2,250
Sugar and molasses	61	5,187	95	7,193
Cotton and cotton seed	872	67,910	964	97,059
Miscellaneous	41	3,164	50	4,480
Total	16,208	169,527	145,002	538,305
RECEIPTS.				
Merchandise	5,891	176,730	12,900	258,000
Total	22,099	346,257	157,902	796,305
Increase over previous year			135,803	450,048

Comparative statement of receipts and shipments for five years.

Year ending May 31—	Tons.	Value.
1890	84,295	$291,967
1891	17,792	300,963
1892	18,530	334,061
1893	22,099	346,257
1894	157,902	796,305

These rivers are navigable 75 miles from mouth of Amite River to Hope Villa on Bayou Manchac. There are some bad places on the streams which are caused from caving banks, fallen trees, and sunken logs, particularly in the 5-mile stretch from Port Vincent on the Amite River up to Bayou Manchac, and also at the mouth of the bayou. These conditions are largely resultant from the flood waters from the Rescue Crevasse, which was caused by the rise in the Mississippi River in 1893. This flood caused a rise of 20 feet in the Bayou Manchac at Hope Villa. The drift and sediment from Rescue Crevasse not only filled the channel where it had previously been cleaned out, but left the condition of the bayou worse than before. On account of these obstructions the regular mail steamer plying between New Orleans and Hope Villa was at times obliged to discontinue trips above Port Vincent.

S 4.

IMPROVEMENT OF BAYOU LAFOURCHE, LOUISIANA.

In 1879 a project was approved for removing the obstructions to navigation in the bayou, such as snags, wrecks, raft heaps, and impending trees. Work was carried on under this project from 1881 until 1883, when the plant was laid up at Lockport after clearing the bayou a distance of 30 miles below that point.

In 1884 a project was approved for continuing the snagging operations on down beyond the place where work had ceased in 1883, and accordingly work was resumed in September, 1884, and continued to January, 1885, when operations were suspended on account of high water. The plant was subsequently removed to other places.

Beyond surveys and examinations nothing further was done until 1888, when Congress appropriated for "improving Bayou Lafourche,

Louisiana, pursuant to the project of Lieut. O. T. Crosby, Corps of Engineers, dated June 11, 1886, $50,000, including immediate dredging to secure low-water navigation."

During eight months of the year, when the Mississippi River is high, Bayou Lafourche is navigable by the largest steamboats, but during extreme low water navigation is sometimes entirely suspended for flatboats drawing over 2 feet of water.

The project referred to in the foregoing act was to place a lock in the Mississippi end of the bayou, converting the bayou into a slack-water stream, and then dredge a channel 75 feet wide and 5 feet deep at mean low water of the gulf throughout its length.

The act also provided for immediate dredging, and since the bar at the river end of the bayou had shut out navigation in 1887 it was proposed to dredge a channel through this bar, the channel to have a depth of 4 feet below mean low water of the gulf and a width of 60 feet. This dredging was done by contract, and admitted sufficient water to the bayou to reestablish flatboat navigation, which had been suspended a day or two while the cut was being made.

It having been ascertained that about 150,000 cubic yards of material would have to be dredged from the bayou to secure 2 feet depth for flatboat navigation, bids were opened June 10, 1889, for dredging this amount, but the price bid was deemed too high and the bid was rejected. Work was then begun by a hired dredge, and continued until high water interfered.

The channel had been carried a distance of about 2 miles from the mouth, and had a depth of 2 to 3 feet at mean low water of the gulf. Upon commencing this dredging, it was found that the channel through the bar at the head of the bayou had shoaled so as to require redredging, and much of the channel work had to be gone over several times owing to the caving of the sides of the cut. On September 15, 1890, dredging was resumed. The dredge had, as formerly, to reopen the cut through the bar at the head of the bayou, and redredge much of the channel previously gone over. The work was suspended in January, 1891, owing to high water; was resumed again on August 5, 1891, and continued until high water again caused its suspension in the latter part of January, 1892.

Upon the subsidence of the high water, work was resumed on August 27, 1892. In order to prosecute the work more vigorously during the low-water season to preserve the flatboat navigation, authority was obtained to hire an additional dredge. The work was commenced at Donaldsonville and was carried on down to the mouth of the bayou, improving about 100 miles of channel. Operations were discontinued April 14, 1893, owing to high water.

Work during the past year, commenced on September 6, 1893, and continued until March 1, 1894, was carried on between Donaldsonville and a point 2 miles above Lockport. During this time 86,113 cubic yards of material, 62 submerged logs, 23 stumps, and 6 wrecks were removed from the channel, making flatboat navigation available for the entire low-water season.

As the silting up of the dredged channel takes place with the recurrence of high water each year, the improvement by dredging is slow and unsatisfactory. The construction of a lock at Donaldsonville will almost entirely overcome this difficulty and render the navigation of the bayou safe and certain under all conditions of the tide in the Mississippi River.

The cost of a lock at *Donaldsonville* was estimated by Lieut. Crosby

to be about $450,000. With this lock completed, whatever dredging was done in the bayou thereafter would be practically permanent, and a moderate annual expenditure would maintain satisfactory navigation hardly possible to secure with any amount of money under the present conditions.

There has been expended on the improvement of this bayou to June 30, 1894, the sum of $119,979.63.

Abstract of appropriations for improving Bayou Lafourche, Louisiana.

By act of Congress approved—	
June 18, 1878	$10,000
March 3, 1879	10,000
June 14, 1880	5,000
July 5, 1884	5,000
By act of Congress of August 11, 1888	50,000
By act of Congress approved—	
September 19, 1890	50,000
July 13, 1892	50,000
Total	180,000

Money statement.

July 1, 1893, balance unexpended	$74,665.47
June 30, 1894, amount expended during fiscal year	14,645.10
July 1, 1894, balance unexpended	60,020.37
Amount (estimated) required for completion of existing project	350,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers running regularly	10
Trips made	502
Steamers not running regularly	14
Trips made	193
Total steamers	24
Total trips	695
Net tonnage, registered, of the total number of steamers	3,151
Total tonnage of the total number of trips	2,189,945
Schooners	4
Trips made	5
Total tonnage, registered	130
Barges, coal, lime, brick, etc., entering the bayou	143
Gross tonnage	130,808
Total vessels	171
Total trips	843
Total tonnage, net	134,089
Total tonnage, gross	2,320,883

Draft of heaviest steamer, light, 3 feet; loaded, 9.6 feet.

Included in the above are 3 small passenger steamers, making trips on the bayou between Lockport and Donaldsonville, La.

Not included in the above are 78 flatboats, which are regularly employed on the bayou both in connection with the steamboat and railroad traffic during the low-water season, 19 more than last year.

Of the steamers regularly employed there were 3 more than last year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Sugar	40,764	$4,487,950	46,510	$5,007,858
Molasses	19,953	665,115	23,145	585,514
Rice	6,549	176,119	3,318	105,897
Potatoes and onions	10,286	298,446	6,089	166,822
Eggs	92	18,540	102	15,367
Moss	208	8,332	213	8,736
Pecans	68	10,920	1	195
Miscellaneous	394	34,409	352	29,208
Total	78,314	5,699,831	79,730	5,919,597
RECEIPTS.				
Miscellaneous	67,634	2,449,050	71,144	2,578,970
Coal	66,528	273,504	122,812	344,375
Grand total	212,476	8,422,385	273,686	8,842,942
Increase over last year			61,210	420,557

The above shipments and receipts were by the all-water route, and are exclusive of those made by part railroad and part water route.

Comparative statement of receipts and shipments for five years.

Year ending May 31—	Tons.	Value.
1890	200,746	$5,709,382
1891	217,273	8,244,225
1892	171,855	5,660,622
1893	212,476	7,422,285
1894	273,686	8,842,942

Bayou Lafourche was navigated during the year a distance of 86 miles below its junction with the Mississippi River. In 1892–'93 the total product of the Lafourche country amounted to 89,251 tons, valued at $6,486,557, 86 per cent of which was shipped by the all-water route to market and the remainder by railroad. During the low-water season bars formed by the flood waters from the Mississippi River interfere seriously with navigation, preventing the steamers from running through and necessitating the use of flatboats. During this year there was flatboat water only over these bars for a period of 167 days, and there was carried in this way up to the head of the bayou for reshipment by steamboat from August to December, 56,000 tons of sugar, molasses, rice, etc., at a cost of $1 per ton more than if shipped by steamboat direct, besides the cost of insurance, rehandling, and loss of time.

The steamboatmen and residents are almost unanimous in their approval of the plan of improvement adopted, but until such time as there are sufficient funds available it would prove a saving in the cost of shipments alone of $56,000 a year if the dredging part of the plan could be carried out.

Of the coal, under the head of receipts, 20 barges, or 18,550 tons, was for consumption by the sugar-planting interests of Bayou Terrebonne, the most available present route to that section for freight in such bulk being down the Lafourche to Thibodaux and thence by rail, and at a cost considerably more than if taken by the former unused and unnavigable all-water route entering from the Bayou Lafourche at Lockport.

S 5.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

Previous to the commencement of the improvement of the Bayou Terrebonne it was a little better than a drainage ditch in places.

The project adopted for the improvement of this bayou contemplated the dredging of a channel 4 feet deep at mean low water of the gulf to Houma, and with the appropriation of $10,000, made in 1880, the work of dredging was commenced in that year and continued until December 17, 1887, when the channel was completed to the railroad depot at Houma, where a turning basin was dug.

The improvement enables planters on the bayou to float their produce to Houma, the nearest railroad station, or else ship by boat direct to New Orleans by way of connecting bayous and canals.

It is doubtful if the improvement can be made permanent, as more or less silt finds its way into the bayou, causing shoals to form, which will require removal from time to time.

The dredge belonging to this appropriation having suffered extensively from decay was put in thorough repair, exhausting the money available for the improvement of this bayou.

The channel dredged by the Government has stood very well, but may require some attention in the near future to keep it in good condition.

The estimated cost of the improvement was $38,800. The completion of the project has cost $35,808.

The amount expended during the year just closed was $1,755.26.

Abstract of appropriations for improving Bayou Terrebonne, Louisiana.

By act of Congress approved—	
June 14, 1880	$10,000
March 3, 1881	8,800
By act of Congress—	
Passed August 2, 1882	7,000
Approved August 5, 1886	10,000
Of August 11, 1888	3,000
Total	38,800

Money statement.

July 1, 1893, balance unexpended	$2,992.00
June 30, 1894, amount expended during fiscal year	1,755.26
July 1, 1894, balance unexpended	1,236.74
July 1, 1894, outstanding liabilities	1,079.34
July 1, 1894, balance available	157.40

COMMERCIAL STATISTICS.

[From June 1, 1892, to May 31, 1893.]

Excepting a few luggers carrying oysters, fruit, and a small quantity of potatoes and onions, there were no vessels employed in the freight business during the past year between New Orleans and Bayou Terrebonne. The only available route, via the Company Canal and numerous lakes and bayous, is so unsatisfactory and uncertain that no vessels can run with profit; therefore the people on the Terrebonne have to depend entirely upon a railroad for means of transportation to market. From

e mouth of the bayou there were delivered to planters 2,700 tons of coal, valued at 5,000, which had been towed in barges from the Mississippi River down to the tchafalaya River, across Berwick Bay, and up the Terrebonne.

The following statistics are for the year ending May 30, 1893:

[From June 1, 1892, to May 31, 1893.]

teamers	3
Trips	15
Tonnage	3,300
arges	3
Trips	9
Tonnage	2,225
otal vessels	6
otal trips	24
otal tonnage	5,525

During the fiscal years 1891 and 1892 there were no steamboats running to New rleans direct, owing to the difficulties and expense of navigation, but during the ear ending May 31, 1893, merchants and planters secured at their own cost means of ansportation with the above results.

Receipts and shipments.

[From June 1, 1892, to May 31, 1893.]

Articles.	Tons.	Value.
gar and molasses	1,189	$129,662
iscellaneous freight	121	5,875
al	1,700	6,660
Total	3,010	142,197

S 6.

MPROVEMENT OF BAYOU PLAQUEMINE, GRAND RIVER, AND PIGEON-BAYOUS, LOUISIANA.

Prior to 1867 or 1868 Bayou Plaquemine was navigable by the largest teamboats, but sometime during the years mentioned the police jury f Iberville Parish, without warrant of law, caused a dike to be built ross the bayou, shutting out the water of the Mississippi River.

Steamers which had used the Plaquemine route to the Teche and ourtableau were thus forced to go by way of the mouth of the Red iver and the Atchafalaya, and at low water, owing to the closing f the mouth of Red River, are compelled to cease running.

The opening of this bayou is therefore of great importance, as, if pened, it would furnish communication at all seasons with the navi-able waters of northern and western Louisiana, which are stated by ood authority to have an available length of 4,300 miles.

In 1885 a project for the improvement of this bayou, by building a ck to connect it with the Mississippi River, and clearing out the chan-el so as to give a depth of 6 feet at mean low-water level of the gulf as presented.

This improvement was estimated to cost $1,708,250.

In 1888 $100,000 was appropriated "for securing a navigable channel feet wide and 6 feet in depth from deep water up to the Plaquemine ike, and for securing the mouth of the bayou from further caving."

As there was no plant at the disposal of this office for the construc-on of dikes, etc., $75,000 of this appropriation was allotted for con-uction of bank protections and turned over to the officer in charge f the fourth district of the Mississippi River in May, 1889.

With the remainder of the funds dredging was commenced June 4, 1889, at a point about 5 miles below the town of Plaquemine, the work being done with a dredge belonging to the United States and hired labor.

Owing to the railroad bridge not being a drawbridge, it was not possible to continue the dredging up to the Plaquemine Dike, as specified in the act of appropriation. The project was accordingly modified so as to stop dredging when the railroad bridge was reached, and when that was accomplished the dredge was turned back and worked down to a point one-half mile below, when work was discontinued and the plant laid up and placed in charge of a watchman.

August 20, 1892, while in charge of a watchman, the dredge boat sank at her moorings. Measures were at once taken to raise the boat, and on September 5 she was floated. An inspection showed the necessity for a general overhauling, and, authority therefor having been obtained, repairs were commenced at once and finished November 20, 1892.

From this date until January 1, 1893, the boat was employed in improving the bayou, removing all obstructions for a distance of 3½ miles.

During the year just closed dredging operations were carried on in the bayou from January 11, 1894, to the end of the fiscal year. During this time 87,940 cubic yards of material, 12 stumps, and 71 logs were removed from the channel. The material excavated consisted mostly of hard blue clay.

The total amount of material removed from Bayou Plaquemine since the commencement of the improvement is 307,927 cubic yards, 1,789 logs, snags, and stumps, many of the latter requiring the use of dynamite to break them up.

GRAND RIVER, AND PIGEON BAYOUS.

The river and harbor act of July 13, 1892, provided that these streams, "forming part of the Bayou Plaquemine route," should be improved, and January 1, 1893, the dredge boat was ordered to Grand River for that purpose.

Work was continued between bayous Sorrel and Pigeon until March 22, 1893, when the rapid rise of the river forced its discontinuance in Upper Grand River, and the dredge was consequently ordered to Flat Lake, on the lower end of this river, with a view of opening up the route to the Teche and Atchafalaya via Grand River.

The operations in the Grand River resulted in the removal of 13,826 cubic yards of material, 5,525 overhanging trees, 667 logs, 16 snags, and 55 stumps.

During the past year obstructions were removed from the mouth of Bayou Sorrel, on Grand River, down the latter stream and through Big Pigeon Bayou to Grand Lake, a distance of 30 miles. The obstructions removed consisted of 1,386 overhanging trees, 98 sunken logs, and 4½ miles of raft. This work was commenced on August 17 and completed October 2, 1893.

The completion of this work opens a competing steamboat route in connection with the Texas and Pacific Railway at Plaquemine, and has already caused a reduction of freight rates from the Teche of 33⅓ per cent.

In order to keep this route open, $10,000 is recommended for the coming year.

l amount thus far expended on the improvement of this route
0.

PLAQUEMINE LOCK.

$100,000 was appropriated for continuing the improvement
Plaquemine, of which sum $60,000 was allotted for com-
e bank protection on the Mississippi River and $40,000 was
) this office.
this last allotment a project for the commencement of work
k to connect the Mississippi River with the bayou was pre-
d a Board of Engineer Officers was appointed to consider the

he direction of this Board plans for a lock of sufficient size to
coal boats, or the largest steamers which would be liable to
of that one lockage, were prepared.
$150,000 was appropriated, with a proviso that "of which
xceeding $10,000 may be used, in the discretion of the Secre-
ar, in removing obstructions from Grand River, and Pigeon
rming part of the Bayou Plaquemine route." For securing
protection at Plaquemine, $72,000 was allotted from this
tion.
amount available for the construction of the lock was not
to warrant the commencement of the work, it has been held
an increase. The estimated cost of lock and approaches is

the fiscal year 1893, titles to all the land expropriated by the
ates for a lock have been obtained. The cost of this land,
court charges, etc., amounted to $34,993.23. The buildings
this property were sold at public auction, and the proceeds
nounting to $2,070.05, were deposited to the credit of the
of the United States.
e bayou is not navigable by vessels engaged in the transpor-
merchandise, owing to the communication with the Missis-
r being cut off, the commercial statistics give no indication
portance of this water route when communication with the
i River shall have been established.
ea of the importance of this line of communication can be
om the following table of the value of the commerce carried
various streams to which access will be afforded by the com-
the Plaquemine Lock. The figures are compiled from the
the Chief of Engineers, and are for the year ending May 31,

.....	$6,877,000
d tributaries.....	6,680,600
and Des Glaises	3,917,344
nemine.....	206,700
.....	1,715,026
ilion	1,500,000
.....	20,896,670

deemed prudent to commence the foundations of the lock
funds available than may be required for the bringing of the
up to the level of low water in the bayou. It is therefore
ly urged that sufficient funds be furnished to accomplish this
elay.
ount expended on this improvement to June 30, 1894, from
tted to this office was $84,109.38, $1,000 of which was

expended for preliminary examinations and surveys from the allotment of $75,000 for bank protection at the mouth of the bayou.

Abstract of appropriations for improving Bayou Plaquemine, Louisiana.

By act of Congress—	
Of August 11, 1888	$100,000
Approved September 19, 1890	100,000
Approved July 13, 1892	150,000
Total	350,000

*Money statement.**

July 1, 1893, balance unexpended	$210,432.91
June 30, 1894, amount expended during fiscal year	150,517.89
July 1, 1894, balance unexpended	59,915.02
July 1, 1894, outstanding liabilities	2,174.85
July 1, 1894, balance available	57,740.17
Amount appropriated by act of August 17, 1894	110,000.00
Amount available for fiscal year ending June 30, 1895	167,740.17
Amount (estimated) required for completion of existing project	1,248,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	6
Net tonnage, registered	434
Trips made	143
Gross tonnage for 143 trips	6,202

Draft of heaviest steamer, light, 2 feet; loaded, 5 feet.

Shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
Sugar and molasses	1,254	$117,730	1,341	$108,310
Moss	25	1,320	3	150
Miscellaneous	350	21,000	3,383	84,575
Cotton and cotton seed	83	3,850	10	1,400
Lumber, shingles, etc	77,044	1,030,850	129,015	361,242
Total	78,756	1,174,750	133,752	555,677
Increase over previous year			54,996	

*This money statement includes amounts for securing mouth of Bayou Plaquemine from further caving. (See Appendix T.)

Comparative shipments for three years.

Year ending May 31—	Tons.	Value.
1892	131,875	$1,343,608
1893	78,756	1,174,750
1894	133,752	555,677

The dredging operations carried on in Bayou Plaquemine made it possible for a large steamboat to be employed regularly during the months of January and February in transporting sugar, merchandise, etc., from and to points on Bayou Teche in connection with a railroad at Indian Village on the Plaquemine. This is the first time a steamboat has been thus regularly employed since the navigation of the bayou was interrupted by the building of a dike across it.

S 7.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

During the high water in the Atchafalaya River a bar forms at the mouth of the Courtableau, but upon the subsidence of the Atchafalaya the reflex water of the bayou causes some scour to take place on the bar.

Acting upon the supposition that if all the water carried by the Courtableau was concentrated upon the bar obstructing its mouth it would be removed, a project was approved in 1879 which had for its object the closing of all bayous flowing out of the Courtableau to the southward, to prevent any escape of water by these lateral streams, and to construct locks and dams so as to make slack-water navigation, first, to Port Barre, 17 miles upstream, and then to Washington, La., 11 miles farther up.

The preliminary estimate for the cost of this work was $40,000, which was afterwards increased to $78,500, and it was reported in the Annual Report of 1886 that the cost of masonry, lock, and dam would be $175,000.

In 1882 dams were built on the Big and Little Fordoche bayous, and timber was slashed into the smaller bayous so as to concentrate the flow of water over Little Devil Bar.

The result was favorable, and 3 feet increased depth of water was obtained in two days.

It was reported that the swampers cut one of these dams afterwards, and Little Devil Bar again shoaled up. In 1885 the cut dam was rebuilt and the other one repaired. A sudden rise caused one of these dams to break, but it was repaired, and during the following summer good results were hoped from the effect the two dams would produce.

In the summer of 1886 the Courtableau was exceptionally low, and Little Devil Bar was shoaler than ever. At its lowest stage a skiff could not be floated over the bar.

From the report of Lieut. Crosby (Annual Report Chief of Engineers for 1887, p. 1376), who made an examination of this stream in September, 1886, it will be seen that the prospects of success, even with all the run-out bayous closed, are anything but certain, yet the closing of two of the principal outlets in one season did produce an increase of 3 feet depth of water. In view of this fact, and that the project called for the closing of these bayous, work was resumed in October, 1886, with the money *appropriated in August* of that year.

Slight repairs were made to the old dams in the Big and Little Fordoche, and a new dam was built in Bayou English. Bayou Mamzelle was similarly closed, and the wings of the dam closing the Big Fordoche were repaired. At the time work ceased in December the bar was cutting out rapidly, there being then a channel of from 3 to 5 feet deep, while when work began there was one of but a few inches in depth. The new channel was then of no use, however, as the closure of Old River permitted no boats to enter the Atchafalaya from the Mississippi River.

The high water of 1888 formed the bar again, as usual, depositing sand to a depth of probably 6 or 8 feet over a length of 2 miles.

From a personal examination made in October, 1888, by Captain Fisk, during low water, it was observed that the preceding high water had cut around one end of each of the dams already built, but they had caused a sand bar to form at each, varying in height from 2 to 3 or 4 feet above the water in the Courtableau at the time of the examination, thus forcing all the water in the bayou to pass out into the Atchafalaya across Little Devil Bar, the head of which was then some 300 or 400 yards above the Little Fordoche. The volume of water, considerably greater than usual at low water, due to heavy local rains, was running with great velocity, and was moving a large quantity of sand, as could be plainly seen, but the depth at the shoalest point could not have been greater than 18 inches.

Had the bar been cut out to a suitable depth for navigation, it is doubtful if it would have left sufficient water in the bayou above for purposes of navigation.

As soon as possible preparations were begun after high water in 1888 to repair the existing dams and to build others, and for closing some of the remaining outlets, but before the plant which was to be used on the work could be put in repair the water rose to such a height that nothing could be done.

The water having fallen sufficiently, work was resumed on September 2, 1889. The broken dams in bayous Mamzelle, English, and Fordoche were all repaired and left in good condition. Bayous Big Cane and Little Cane, both of which are small and of little importance, were obstructed by slashing trees into them, and the boats taken to Bayou Juramon on November 23 for work; but the water rose so rapidly the plant and lumber had to be taken to Washington, laid up, and the crew discharged November 30, 1889.

Nothing was done during the fall of 1890 beyond slight repairs to the derrick boat, and, owing to high water, work was not resumed until September of the following year.

The dams at bayous Cane, Mamzelle, and Big Fordoche were all repaired with piles and sheet piles, brush aprons placed above and below them, held down by sinking trees and earth, and left in good order. The work was discontinued November 20 and the plant laid up at Washington, La.

Through the influence of the dams constructed, the bar has washed out so as to give a navigable depth at a stage of water in the Atchafalaya 7 feet below the level at which navigation was interrupted in the summer of 1891, but it is doubtful if the completion of the present project will permanently remove the bar at the mouth, as Little Devil Bar will reform at each high water of the Atchafalaya River.

The dams are in fairly good condition, but will require extensive repairs in another year, particularly the older ones.

No work was done during the past year.

To June 30, 1894, there has been expended on the improvement of Bayou Courtableau the sum of $31,036.48.

For continuing the improvement by constructing dams and repairs to those already built, the sum of $5.000 can be economically expended during the ensuing year.

Abstract of appropriations for improving Bayou Courtableau, Louisiana.

By act of Congress approved—	
June 14, 1880	$7,500
March 3, 1881	7,500
July 5, 1884	4,000
August 5, 1886	5,000
By act of Congress—	
Of August 11, 1888	5,000
Approved September 19, 1890	2,200
Total	31,200

Money statement.

July 1, 1893, balance unexpended	*$163.52
July 1, 1894, balance unexpended	163.52
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	5,000.00

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	2
Trips made	27
Gross tonnage, registered	7,644

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Sugar and molasses	467	$36,664	1,728	$162,056
Rice	2,075	55,347	1,014	31,244
Cotton and cotton seed	4,497	194,764	3,685	126,137
Miscellaneous	107	5,654	68	4,374
Total	7,146	292,429	6,495	323,811
RECEIPTS.				
Merchandise	7,702	385,100	2,700	162,000
Grand total	14,848	677,529	9,195	485,811

* Six dollars and seven cents of this amount refunded by Southern Pacific Railroad Company on account of overpayment on freight charges between New Orleans and Morgan City, La.

Comparative statement of receipts and shipments for five years.

Year ending May 31—	Tons.	Value.
1890	35,867	$4,629,684
1891	32,618	3,917,344
1892	20,041	994,471
1893	14,848	677,529
1894	9,195	485,811

Long-continued low water over the bar at the mouth of the bayou prevented boats from entering until late in the season and after much of the crop had been hauled for shipment by railroad.

S 8.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

Ordinarily this bayou is navigable for steamboats throughout the year.

Prior to 1886 logs, snags, and impending trees obstructed the channel, but money having been appropriated the stream was thoroughly cleared of such obstructions from Port Barre down.

In 1890 Congress appropriated $5,000 with which to remove the obstructions that had found their way into the bayou since 1886.

Operations were commenced at St. Martinsville in October, 1891, with hired plant, and the improvement extended to a point about 59 miles below. Work was discontinued December 10, 1891. The main obstructions removed from the channel as the result of the year's work were 238 snags, 144 piles, 98 overhanging limbs, 36 overhanging trees, 30 fallen trees, 50 sunken logs, 18 floating logs, and 37 stumps.

To the close of the year ending June 30, 1894, there has been expended on the improvement of this stream the sum of $54,435.01.

The improvement of the Teche can not be considered as permanent, as sunken logs, fallen trees, and wrecks of coal boats are constantly forming obstructions which will require removal.

The navigation of the stream is at present also obstructed by shoals, on which, during the prevalence of northers in the low-water season, the available depth is frequently not more than 3 feet. These shoals are formed by material washed into the stream from the large drainage ditches, and while no one of them is very long, they form a series of dams over which it is impossible for the steamers to carry full loads. The evil is increasing, as every year new ditches are opened and old ones cleaned out.

It is generally upon these shoals that the sinking logs drop out from passing rafts, making the passageway dangerous.

As the low-water season occurs at the time of marketing the crops, this condition is becoming of serious import to the various interests involved.

It is believed that $30,000 can be most advantageously expended during the ensuing year in dredging and removing obstructions from the channel.

Abstract of appropriations for improving Bayou Teche, Louisiana.

By act of Congress approved—	
July 11, 1870	$17,500
June 14, 1880	6,000
March 3, 1881	20,000
July 5, 1884	6,500
September 19, 1890	5,000
Total	55,000

Money statement.

July 1, 1893, balance unexpended	$612.51
June 30, 1894, amount expended during fiscal year	47.52
July 1, 1894, balance unexpended	564.99
Amount that can be profitably expended in fiscal year ending June 30, 1896	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	27
Net tonnage, registered	2,574
Trips made	1,233
Net tonnage for the 1,233 trips	3,173,742
Barges	185
Net tonnage	146,700
Trips made	1,546
Total vessels	212
Total trips made	2,779

Draft of heaviest steamer, light, 2 feet; loaded, 5.6 feet. Draft of heaviest barge, light, 12 inches; loaded, 8 feet.

The bayou is navigated from its mouth up to Breaux bridge, a distance of 145 miles. The upper portion of the bayou is becoming difficult of navigation by caving banks and trees.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
SHIPMENTS.				
Sugar	11,259	$3,580,361	47,305	$4,841,144
Molasses	7,829	261,008	9,303	210,802
Rice	4,325	123,335	1,536	47,355
Potatoes and onions	62	1,336	21	593
Eggs	55	6,054	16	2,312
Moss	97	3,107	51	2,056
Pecans	82	4,680	22	360
Hides	39	3,509	12	784
Cotton and cotton seed	324	38,982	4,076	230,157
Cotton-seed oil	176	17,600	146	11,869
Wood			375	4,375
Miscellaneous—merchandise, lumber, bricks, etc	897	38,825	29,537	159,915
Total	25,145	4,078,797	92,400	5,511,722
RECEIPTS.				
Machinery, merchandise, coal, sawlogs, etc	90,135	1,675,745	290,754	1,867,067
Grand total	115,280	5,754,542	383,154	7,378,789
Increase over previous year			267,874	1,624,247

Comparative statement for four years.

Year ending May 31—	Tons.	Value.
1891	26,905	$1,715,026
1892	64,866	833,110
1893	115,080	5,754,542
1894	383,154	7,378,789

There are three ways of shipping to market, one by the all-water route, via the Atchafalaya and Mississippi rivers; another by way of Bayou Plaquemine and rail, and the third—the one almost exclusively used because of its certainty—is by steamer to points on the bayou, and thence by rail. The first, or all-water route, is not entirely satisfactory, because the distance to be traversed is so much greater (270 miles). However, a steamboat was run regularly over this route during the last four months. This, together with the attempt of the Texas and Pacific Railroad to establish a connection by running a steamer between the bayous Teche and Plaquemine up to Indian Village (which would not have been possible except for the dredging recently done in Plaquemine), resulted, perhaps, in a considerable reduction in freight rates made since by the other competing route, i. e., by boat and from the Teche by rail direct, the route over which 90 per cent of the traffic passes. It may be that this reduction was made for the effect it would have in discouraging competing carriers, but, in any event, it will result in a very large saving to the Teche people in freights, the saving on sugars alone amounting to $56,000 in a single year. The permanency of this, however, with the certainty of even further reductions, can be best and only obtained by the building of locks in Bayou Plaquemine, thus reopening a route always preferred and greatly desired because of its being so much shorter, quicker, cheaper, and a more satisfactory means of communication.

S 9.

IMPROVEMENT OF CHANNEL, BAY, AND PASSES OF BAYOU VERMILLION, LOUISIANA.

In 1891 a preliminary examination was made of the bayou, bay, and passes.

A project was approved in 1892 which provided for the removal of snags, overhanging trees, and logs in the bayou, and the driving of guide piles in the bay for marking the channels, at an estimated cost of $25,000.

An appropriation of $7,500 was made for this work July 13, 1892.

Bids were invited by advertisement for furnishing a suitably equipped steamboat for the work in the bayou and bay. The proposals submitted were opened October 7, 1892, and the award of contract was made to Victor Von Schoeler, of Franklin, La., for the best and most suitable boat of those offered.

The plant contracted for consisted of a stern-wheel steamboat, with a crew of fourteen men, supplied with a steam capstan, steam winch, derrick, blocks and tackle, and one electric battery for removing obstructions, and one pile-driver for driving guide piles in Vermillion Bay.

The contractor commenced snagging operations about 18 miles above the mouth of the bayou on December 1, 1892. The work was carried on up the bayou, and resulted in the improvement of 37½ miles of channel by the removal of 3,032 obstructions, consisting of 2,377 overhanging trees, 416 overhanging limbs, 110 snags, 58 sunken trees, 36 stumps, and 35 logs. The contractor completed the snagging work on March 9, 1893, but owing to the loss of his boat he was unable to complete the driving of the guide piles in the bay by the date of the expiration of the

ntract, and an extension of time to July 31, 1893, was granted, within hich to finish this work.

The work done during the past year was the completion by the contractor, on July 25, 1893, of the driving of the 50 guide piles for marking the channel in Vermillion Bay.

The sum of $10,000 can be most advantageously expended on this improvement during the next year.

The total amount expended to June 30, 1894, was $7,054.19.

Abstract of appropriations for improving the channel, bay, and passes of Bayou Vermillion, Louisiana.

By act of Congress approved July 13, 1892	$7,500

Money statement.

July 1, 1893, balance unexpended	$1,576.80
June 30, 1894, amount expended during fiscal year	1,130.99
July 1, 1894, balance unexpended	445.81
Amount (estimated) required for completion of existing project	17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	5
Trips made	525
Gross tonnage, registered	22,286
Schooners	7
Trips made	84
Gross tonnage, registered	7,728
Barges	10
Trips made	607
Gross tonnage	26,497
Total vessels	22
Total trips	1,216
Total tonnage	56,511

Draft of heaviest vessels, light, 2½ feet; loaded, 6 feet.

No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
Lumber	1,200	$14,400	26,500	$33,000
Rice	4,200	83,200	1,341	39,900
Cotton	925	120,250	884	122,870
Cotton seed	1,100	13,200	1,372	24,054
Wood	10,000	10,000	.....	.....
Cattle	75	50,000	1,135	25,900
Sugar	2,979	272,765	2,611	284,852
Molasses	957	31,900	201	6,900
Merchandise	12,570	624,990	7,281	374,151
Coal	1,665	6,660	2,497	12,150
Total	35,671	1,227,365	43,822	923,777
Increase over previous year			8,151	.....

S 10.

IMPROVEMENT OF MERMENTAU RIVER AND TRIBUTARIES, LOUISIANA.

In 1891 a survey of this river was made, including its tributaries and course through Lake Arthur and Grand Lake to the Gulf of Mexico, Louisiana.

The project adopted in 1892 was estimated to cost $23,615.25, and provided for the removal of snags, logs, and overhanging trees in the upper river and a mud flat in the lower.

July 13, 1892, Congress appropriated $7,500 for this improvement.

Bids were invited by advertisement for furnishing a suitable steamboat for snagging purposes. The bids submitted were opened October 6, 1892, and the award of contract was made to Harvey & Erlinger, of Harveys Canal, Louisiana, they having the best and most suitable boat of those offered.

The plant contracted for consisted of a stern-wheel steamboat, with a crew of 15 men, supplied with a steam capstan, steam winch, and 2 derricks for removing obstructions, 1 electric battery for blasting stumps, and all other necessary appliances for this class of work.

Work under this contract was commenced December 8, 1892, at the lower end of Lake Arthur, and proceeded on up the Mermentau River, improving that part of the channel most used for a distance of 38 miles, by removing 556 obstructions, consisting of 383 snags, 172 overhanging trees, and 1 wreck. The contract was completed March 7, 1893.

The sum of $10,000 can be advantageously expended on this improvement during the next year.

The total amount expended on these streams to June 30, 1894, was $7,076.11.

Abstract of appropriations for improving Mermentau River and tributaries, Louisiana.

By act of Congress, approved July 13, 1892	$7,500

Money statement.

July 1, 1893, balance unexpended	$445.97
June 30, 1894, amount expended during fiscal year	22.08
July 1, 1894, balance unexpended	423.89
Amount (estimated) required for completion of existing project	16,115.25
Amount that can be profitably expended in fiscal year ending June 30, 1896	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	6
Trips made	261
Gross tonnage, registered	54,027
Schooners	4
Trips made	80
Gross tonnage, registered	7,200
Barges	9
Trips	75
Total tonnage	3,000
Total vessels	19
Total trips	316
Total tonnage	64,227

* Draft of heaviest vessel, light, 2.8 feet; loaded, 4 feet.

No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
[illegible]	11,900	$309,400	4,265	$150,000
[illegible]mber	150	1,500	240	1,875
[illegible]ood	4,000	4,000	300	1,875
[illegible]erchandise	200	10,000	632	35,200
Total	16,250	324,900	5,437	188,950

S 11.

IMPROVEMENT OF MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIANA.

In 1874, and again in 1882–'83, cuts were made through the bars in Calcasieu Lake above Calcasieu Pass. The dredged channel was 8 feet deep, 70 feet wide, and 7,500 long. The work was done under contract. The channel had again shoaled in 1885 to a depth of 3½ feet and needed redredging, but by an unfortunate wording of the appropriation, funds in hand for "improving Calcasieu River" could not be applied to this particular work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and river.

Contracts were made in 1886 for building two revetment walls of piles and planks, one on each side of the proposed cut, to be about 130 feet apart, each to be a mile or more in length, and between these to dredge a channel 100 feet wide and 6 feet deep, the material excavated to be thrown outside the revetment walls.

The same contract also provided for the excavation of a channel through the bar at the mouth of Calcasieu River, at the northern end of the lake, 100 feet wide and 6 feet deep. Work was commenced on the revetments in the winter of 1886, but the weather was so severe that the contractor and several of his men died from sickness due to exposure on this work.

In the spring of 1887 work was resumed by the administrator of the contractor's estate, and the revetment nearly completed. At the date of the annual report for 1887 a dredge was expected to begin work within a few weeks, and actually arrived there about the middle of August, but was not ready for work until the last of November on account of the repairs necessary and the delay in making them.

About the middle of September, when it was thought the dredge would be ready for work in a few days at the very latest, the administrator began driving down the planking of the revetment into the ditch the water had dug under it, but after one day's work stopped. No work was done by him after that time, and the contract was annulled January 3, 1888.

Authority was obtained from the Chief of Engineers to do this work by hired labor and open-market purchase, using the Government dredge which had shortly before finished the improvement of Bayou Terrebonne. A careful examination developed the fact that the revetment was so badly worm-eaten as to be worthless, showing that the life of timber there was short. Application was made to so far modify the project as to omit the revetment, and this modification was approved by

the Chief of Engineers January 12, 1888. The dredge was put in good condition and began work on the 19th of March.

Two deck barges were hired and arranged for use as dump scows, but two days' work with them showed that the wooden shafts or Spanish windlasses, used for closing the dumping doors, were not strong enough. These were replaced with 3-inch iron shafting and worked well. The material taken out by the dredge amounted to 77,159 cubic yards, completing the work as projected August 31, 1888.

In 1888, $10,000 was appropriated for continuing this work, but as the former work did not prove to be permanent, and the amount was too small to begin operations with, it was held subject to future consideration.

In 1890, Congress appropriated $75,000 for "improving the mouth and passes of Calcasieu River" according to the plan reported by Maj. W. H. Heuer, Corps of Engineers, in 1886, and confirmed by Capt. W. L. Fisk, Corps of Engineers, in his report of November, 1888.

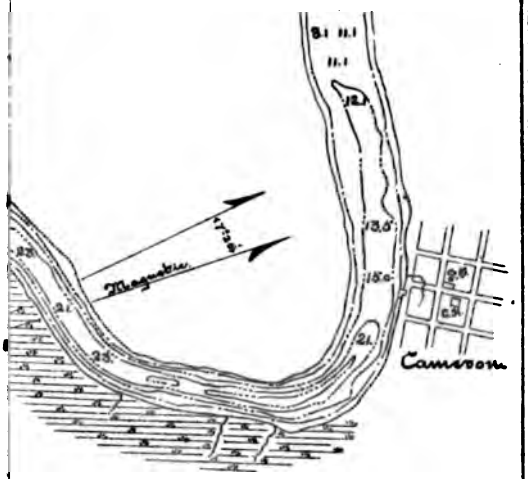
As this project was for the improvement of the mouth of the Calcasieu River by means of jetties, etc., which must be built in a very much exposed location in the gulf, the amount of money available was considered to be entirely too small with which to commence operations economically, and was accordingly held for future increase.

The act approved July 13, 1892, appropriated $100,000 for the improvement of the passes and river, and accordingly a contract was let for the construction of a jetty upon the east side of the channel across the bar at the mouth of the pass, and a contract for 10,000 linear feet of revetment for the northern side of a channel to be dredged through the bar at the head of the pass. For the dredging, although advertised, no bid was received sufficiently low to warrant acceptance, and accordingly authority was obtained for digging this channel with the Government dredge.

The 10,000 linear feet of revetment was completed August 6, 1893, the contractor using in its construction 3,345 piles and 44 barge loads of slabs. In November, 1893, the revetment was considerably damaged by storm, and $3,102.80 was expended in its repair. A subsequent storm resulted in some damage, but no funds are available with which to further repair the structure.

The dredging was commenced in July, 1893, and considerable progress was made, barring temporary suspensions for repairs, until February, 1894, when the dredge, having become unserviceable through decay, was hauled out and put in thorough repair, since which date no dredging has been done. Repairs to the dredge being now completed, work will probably be resumed early in the ensuing year.

The material removed from the channel during the year amounted to 144,634 cubic yards. The material was very soft and flattened out without making a bank, as was expected. In consequence the revetment did not receive the protection from this source that was expected and was accordingly nearly swept away by the severe storm of November, and still further damaged by the storm in December following. A substantial structure for the breakwater could not be built for the allotted amount of money that would withstand the effect of storms without the protection of the earth covering, and as this proved to be too soft to be of any use the wreck was inevitable and the result very disappointing. The channel dredged has remained in use and has afforded considerable relief. When dredging is resumed a greater depth will be given to the cut with the hopes of securing material of greater consistency.



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...accompany annual report
J. Barnes
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The contractors continued work on the east jetty through the year, but owing to unfavorable weather retarding operations they have been granted an extension of time until August 1, 1894, within which to complete their contract.

This jetty will be similar to those at Sabine Pass, viz, a foundation mat of brush, and upon this a riprap structure to reach 2 feet above mean high water.

The east jetty has now a total length of 6,857 feet, the material used during the year in its construction being 26,029.43 tons of riprap stone and 16,265.56 square yards of brush mattress.

The effects of the jetty are apparent in the change in direction of the channel across the bar, but since the depth is about the same as usual it is not believed that the required depth can be secured without the assistance of the west jetty and perhaps some dredging.

The total amount expended on the improvement to June 30, 1894, was $174,544.46.

Abstract of appropriations for improving mouth and passes of Calcasieu River, Louisiana.

By act of Congress approved—	
June 10, 1872	$15,000
March 3, 1881	15,000
By act of Congress—	
Passed August 2, 1882	10,000
Approved July 5, 1884	6,500
Of August 11, 1888	10,000
Approved September 19, 1890	75,000
Approved July 13, 1892	100,000
Total	231,500

Money statement.

July 1, 1893, balance unexpended		$175,037.05
June 30, 1894, amount expended during fiscal year		118,081.51
July 1, 1894, balance unexpended		56,955.54
July 1, 1894, outstanding liabilities	$26,558.05	
July 1, 1894, amount covered by uncompleted contracts	21,929.56	
		48,487.61
July 1, 1894, balance available		8,467.93

Amount (estimated) required for completion of existing project	425,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	350,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	11
Trips made	704
Net tonnage, registered	299
Total tonnage for 704 trips	210,496
Schooners	28
Net tonnage, registered	1,280
Trips made	485
Total tonnage for 485 trips	135,800
Barges	10
Trips made	312
Gross tonnage	23,400
Total vessels	49
Total trips made	1,501
Total tonnage	369,696

Draft of *heaviest vessel, light, 4 feet; loaded, 6.6 feet.*

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
Lumber	180,000	$990,000	289,253	$1,030,819
Shingles	6,000	60,000	39,375	78,750
Cotton	525	68,250	571	79,625
Cotton seed	550	6,600	.....	.....
Rice	252	6,000	832	26,550
Merchandise	20,218	1,010,900	14,942	384,830
Total	207,545	2,141,750	344,973	1,600,574
Increase over previous year			137,428	.....

Calcasieu River is navigated 105 miles above its mouth. The board of trade and mill owners of Lake Charles contributed $8,500, besides material, for use in obtaining a 7-foot depth over the bar, the result of which has been an increase in arrivals from the gulf and a reduction of $1.35 per 1,000 feet in the cost of shipping lumber, and increasing the sales. One firm alone made a shipment of 200,000 feet to Galveston, Tex., a delivery that could not have been made before the bar was dredged. It is claimed that the Calcasieu pine is especially valuable for boat building, and with an assured greater depth over the bars the shipbuilding interests of Lake Charles would be greatly benefited.

S 12.

IMPROVEMENT OF HARBOR AT SABINE PASS, TEXAS.

The original depth of water on the bar obstructing the entrance to Sabine Pass, Tex., did not exceed 6 feet. Attempts were made in 1878 and 1880 to increase this to 12 or 16 feet by dredging, but the dredged channels, being unprotected, soon filled up. In 1882 a project was approved for improving this entrance by means of jetties and dredging, at an estimated cost of $3,177,606.50.

Since the approval of this project there has been appropriated $1,448,750. A total of $1,528,593.79 had been expended to June 30, 1893, of which sum $1,208,593.79 was expended upon the present approved project.

At the start the jetties were built of layers of brush and rock ballast, but it was found that the brush which was placed in the jetties above the bottom course almost entirely disappeared, and at present a large brush mattress is sunk for a foundation, and the rock jetty is built upon this until the crest is about 2 feet above mean high water.

Owing to the bottom upon which the mats rest being of a rather yielding material, some subsidence is to be expected, and in construction an allowance has been made for this, but upon the whole the subsidence has not exceeded expectations. Some loss of height also results from the displacement of the rock by wave action, and since it is impossible to definitely separate this from actual subsidence it has not been possible to adjust the different elements of jetty construction so as to exactly meet all the conditions of permanent structure.

CHANNEL BETWEEN JETTIES.

During the past year dredging was carried on from July 1, 1893, to February 23, 1894, on which date the contract was completed. The quantity of material removed from the channel between these dates

amounted to 198,401.26 cubic yards, and since the commencement of dredging in February, 1893, 357,777.84 cubic yards.

The channel is now 100 feet wide and full 16 feet deep at mean low tide from deep water in the pass to the 17-foot contour of depth in the gulf.

No appreciable filling has occurred in the channel where it is not protected by the jetties, as was thought would likely occur. The manner in which this channel beyond the jetties has preserved its depth and width is very encouraging indeed, and proves that, with some further extension of the east jetty, it will be possible to maintain a depth of water at this entrance far greater than was supposed. Although the channel was dredged to full 16 feet depth only, vessels drawing 17.5 feet have passed out safely and without delay.

JETTIES.

The work upon the west jetty was continued from the first of the fiscal year to June 15, 1894, the contract being completed on the latter date.

The material placed in the jetty during this time amounted to 39,150.29 gross tons of riprap stone, and 23,333.31 square yards of brush mattress.

The east jetty has a total length of 17,100 feet, 16,615 feet of which was raised to 2 feet above mean high water, 35 feet up to mean low water, and the outer 450 feet consisting of foundation work only. The crest of rock section is 9.8 feet above mean low water.

The west jetty is 14,875 feet long, 6,609 feet of which is raised to 2 feet above mean high water, and 7,966 feet has been brought up to mean low water. The outer 300 feet is foundation work only.

Some slight subsidence of the east jetty has been noted; about 9,000 feet has settled from 1½ to 2 feet. Some of this subsidence must be credited to displacement of the capping stones by wave action, particularly the outer 3,000 feet, where the top of the jetty is now only about at the level of mean high water. The rock section has apparently settled about 0.2 feet, or an inappreciable amount practically. There is being built upon this rock section a concrete triangulation station for experimental purposes. It will have a height of 11.3 feet above mean low water and will be completed early in July.

The west jetty has not settled materially beyond what was due to the settling of the mattress at the time of construction, which has only amounted to 1.2 feet. The outer end is about 2,000 feet farther out in the gulf than the east jetty, and although without the protection of heavy capping stones has stood so far very well.

The total amount expended on this improvement to June 30, 1894, was $1,716,091.96.

Abstract of appropriations for improving harbor at Sabine Pass, Tex.

From act approved August 30, 1852 (survey)	$5,000
Allotted from act of Congress approved June 10, 1873 (for survey)	2,000
By act of Congress approved—	
March 3, 1875	20,000
August 14, 1876	38,000
June 18, 1878 (allotted)	30,000
March 3, 1879	25,000
June 14, 1880	50,000
March 3, 1881	150,000
By act of Congress passed August 2, 1882	150,000

By act of Congress approved—	
July 5, 1884	$200,0
August 5, 1886	198,7
By act of Congress of August 11, 1888	250,0
By act of Congress approved—	
September 19, 1890	300,0
July 13, 1892	350,0
Total	1,768,7

Money statement.

July 1, 1893, balance unexpended	$240,156.3
June 30, 1894, amount expended during fiscal year	187,498.1
July 1, 1894, balance unexpended	52,658.(
July 1, 1894, outstanding liabilities	44,310.(
July 1, 1894, balance available	8,347.1
Amount (estimated) required for completion of existing project	1,728,856.5
Amount that can be profitably expended in fiscal year ending June 30, 1896	1,000,000.(
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Vessels	
Trips	
Tonnage, registered	15,(

Draft of heaviest vessel coming in, 16.3 feet; draft of heaviest vessel passing o 17.5 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Valu
SHIPMENTS.				
Lumber	9,780	$117,060	28,892	$173,
Merchandise	450	22,500	580	14,
Total	10,230	139,560	29,472	188,
RECEIPTS.				
Rock	3,290	9,870	13,774	43,
Coal	950	3,800	2,700	11,
Merchandise	500	25,000	1,020	36,
Brick	80	2,720	.....	.....
Grand total	15,050	180,950	46,966	280,
Increase over previous year			31,916	99,

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Valu
1892	38,028	$225,
1893	15,050	180,
1894	46,966	280,

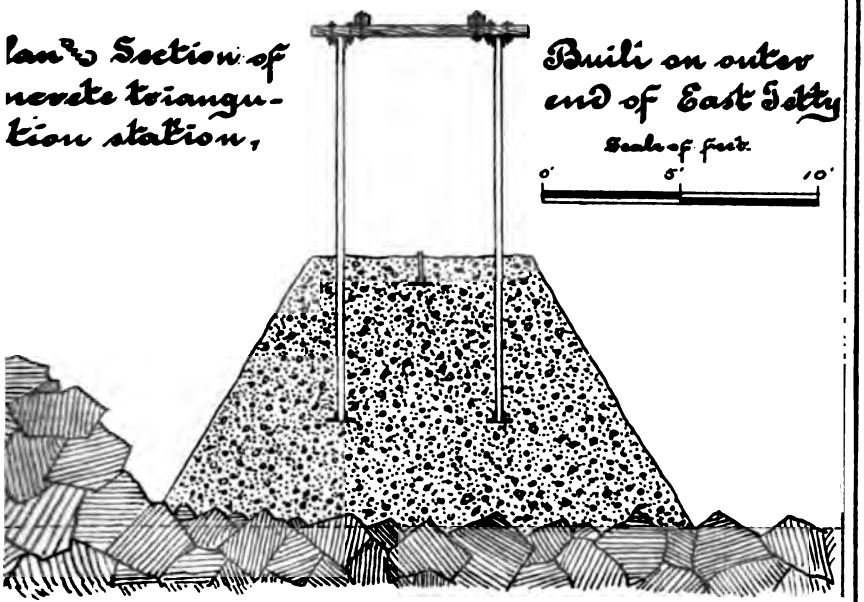
Improving Sabine Pass, Texas.

Land Section of concrete triangulation station,

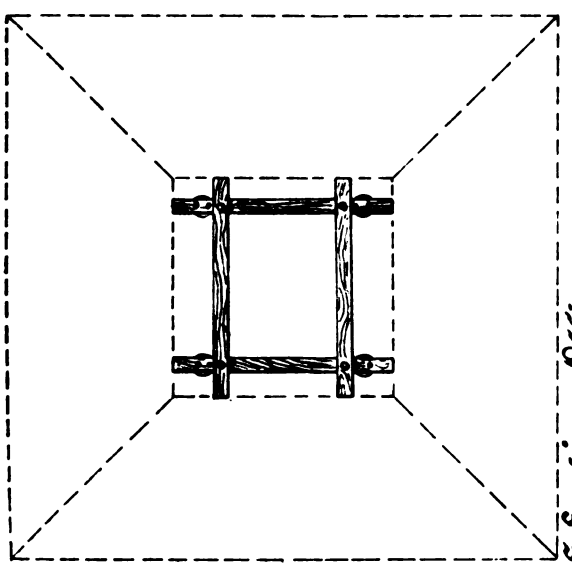
Built on outer end of East Jetty

Scale of feet.

0' 5' 10'



SECTION



PLAN

U.S. Engineer Office.
New Orleans, La. June 30, 1894.
James B. Quinn
Major, Corps of Engineers, U.S.A.

The Friedenwald Co. Photo-Lith., Balto., Md.

Eng. 58 8.

S 13.

IMPROVEMENT OF SABINE RIVER, TEXAS.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep. In 1872–'73 the survey was extended from the mouth to Belgora, Texas. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year.

The estimated cost of improvement over this stretch of river by the removal of obstructions, such as logs, snags, fallen trees, etc., was $18,000.

Congress appropriated $10,000 in 1878 for the improvement, with which a channel 6 feet deep, 70 to 100 feet wide, was dredged over the bar at the mouth.

In 1879 Congress appropriated $6,000 more, and provided for a resurvey of the river from its mouth to East Hamilton. After the survey was completed it was deemed advisable to spend this money in improving the river above Orange, and cuts were made from the main river into the Narrows and at Dead Bend.

Large numbers of sunken logs and snags were removed from the upper part of the Narrows, enabling vessels of 5 feet draft to get 30 miles above Orange.

In 1880 Congress appropriated $5,000, and in 1881 $7,000 more, for this river. The bar at the mouth had again shoaled. This was redredged in 1881–'82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length, which still remains in fair condition.

In 1882 Congress appropriated $4,000 more for this improvement. As the river was in a sufficiently good condition for the limited commerce which it carried, this money was held for further use.

An examination in May, 1889, showed many snags and some shoal places in the part of the channel known as the Narrows, and as some $4,000 was available for work, a project was submitted for removing the snags and closing the two "Old River" branches with dams of piles, brush, and earth, to throw all the water into the Narrows.

This project was approved, the work advertised, and contract was entered into September 20, 1889, with the Sabine Tram Company to complete the work by December 1, 1889, for $3,647.

The smaller dam was successfully built, and most of the piles driven for the larger one, when a sudden rise in the river washed out many of them. The water continued rising and remained so high that satisfactory work could not be done, so that the contract was extended to October 30, 1890, by the Chief of Engineers. Work was resumed in September, 1890, and finished in December of that year, completing the project.

The approved project of 1892 provides for the improvement of the river between Sabine Lake and Sudduths Bluff by the removal of snags and other obstructions, at a cost of $10,000.

July 13, 1892, an appropriation of $5,000 was made for improving Sabine River up to Sudduths Bluff, Texas.

Bids were invited for furnishing a steamboat for work under this appropriation. Those received were not deemed advantageous to the Government, and they were rejected with the approval of the Chief of Engineers. The work was readvertised and bids were opened April 21, 1893.

The award of contract was made to Liles & Allardyce, of Burkeville, Tex., for the best and most suitable boat at the most reasonable price.

The plant contracted for consists of a stern-wheel steamboat, with a crew of 12 men, a steam capstan, hoisting machine, etc., electric battery, fuses, and dynamite for removing obstructions from the river.

The contractor commenced work on July 1, 1893, and completed the same on September 26 following, during which time 1,325 obstructions were removed from the channel, consisting of 337 overhanging trees, 535 sunken logs, 221 sunken trees, 95 floating logs, 64 snags, 41 overhanging limbs, and 32 stumps.

The work was commenced at a point 18 miles above Orange, and resulted in improving 17½ miles of channel.

It is estimated that $2,000 will be required annually to keep the river in condition after the snags are removed.

There has been expended on the improvement of this river to June 30, 1894, the sum of $39,531.97.

Abstract of appropriations for improving Sabine River, Texas.

Allotted from act approved June 10, 1872	$2,700
By act of Congress approved—	
June 18, 1878	10,000
March 3, 1879	6,000
June 14, 1880	5,000
March 3, 1881	7,000
By act of Congress—	
Passed August 2, 1882	4,000
Approved July 13, 1892	5,000
Total	39,700

Money statement.

July 1, 1893, balance unexpended	$4,904.96
June 30, 1894, amount expended during fiscal year	4,736.93
July 1, 1894, balance unexpended	168.03
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	6
Trips made	241
Gross tonnage, registered	534
Gross tonnage for 241 trips	128,694
Schooners	21
Trips made	72
Gross tonnage, registered	513
Gross tonnage for 72 trips	36,936
Barges	6
Trips	117
Gross tonnage	3,334
Total vessels	33
Total trips	430
Total tonnage of the total number of trips	168,964

Draft of heaviest steamer, light, 20 inches; loaded, 4.6 feet.

No new lines of transportation were established this year.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
Lumber	137,368	$891,180	230,602	$1,047,305
Cotton	1,750	227,000	1,170	151,000
Cotton seed	1,925	23,100	1,445	17,325
Staves	4,000	318,000	2,600	212,000
Wool	120	72,000	40	46,000
Merchandise	1,200	60,000	800	45,000
Total	146,363	1,591,280	245,657	1,518,630
Increase over previous year			99,294	

Steamers run from the mouth of the river to Logansport, a distance of 508 miles, from which point lighter steamers run 300 miles above to Longview.

The statistics given in this report are for the lower part of the river.

On account of the low-water period lasting longer than usual, a large falling off in all river traffic occurred, with the exception of lumber, much of which was rafted.

S 14.

IMPROVEMENT OF NECHES RIVER, TEXAS.

The river was surveyed in 1872 and 1873, and resurveyed from Bevilport to its mouth.

The project for improvement contemplated the dredging of a channel over the bar at the mouth and removal of obstructions from the river between Bevilport and Yellow Bluff.

In 1880 the bar at the mouth was dredged and a channel 5 feet deep and 30 to 60 feet wide was obtained. The obstructions in the river between Yellow Bluff and Bevilport were removed in 1882.

The original estimate of the cost of improvement was, for work at the mouth of the river, $26,318.05; and for up river, $15,000; a total of $41,318.05.

The bar at the mouth of the river again shoaled until at extreme low water there was a depth of about 3 feet over it.

There is very little commerce passing in and out of the river, but as the bar at this place was the shoalest obstruction between the gulf and Beaumont, Tex., and the money was available for dredging the bar, it was thought advisable to reopen this channel.

The Government dredge, which had completed work at the head of Calcasieu Pass, was placed in good repair and sent over to the mouth of the river in December, 1888, for the purpose of redredging the channel over the bar. By the 1st of May following the dredge had removed 55,482 cubic yards of material and completed a 5-foot channel on the line of the old one, of which traces still remained.

The total amount thus far expended upon the improvement of this river is $28,842.16, leaving still unexpended $4,157.84.

The dredged channel can not be expected to be permanent in such a broad and shallow body of water as Sabine Lake, but will probably serve all the necessities of the commerce using it for several years.

Abstract of appropriations for improving Neches River, Texas.

By act of Congress approved—	
June 18, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	3,000
March 3, 1881	5,000
By act of Congress passed August 2, 1882	5,000
By act of Congress approved July 5, 1884	7,000
Total	33,000

Money statement.

July 1, 1893, balance unexpended	$4,157.84
July 1, 1894, balance unexpended	4,157.84

COMMERCIAL STATISTICS.

[From June 1, 1893, to May 31, 1894.]

Steamers	2
Trips made	61
Gross tonnage, registered	7,805
Schooners	2
Trips made	2
Gross tonnage, registered	46
Barges	4
Trips made	13
Gross tonnage	4,240
Total vessels	8
Total trips	76
Total tonnage	12,091

Draft of heaviest steamer, light, 14 inches; loaded, 4 feet.

Receipts and shipments for two years.

Articles.	Year ending May 31—			
	1893.		1894.	
	Tons.	Value.	Tons.	Value.
Lumber	75,630	$421,660	164,319	$493,754
Cotton	500	65,000	183	26,000
Hides	18	1,500	6	5,000
Wool	60	36,000	20	14,000
Cattle	300	40,000	200	15,000
Merchandise	725	36,250	800	40,000
Total	77,533	600,410	165,528	593,754

The river is navigated from its mouth to Irish Bay, 280 miles above. Since the deepening of the water to 16 feet and more, at Sabine Pass, the lumber business of the Neches River has largely increased, sales now being made to the West Indies, Mexico, and South American markets, but owing to several shoals in Sabine Lake vessels can not get into the river, and have to be loaded at the Pass. A much larger part of the lumber is carried to the Pass by railroad at $1 per 1,000, freight. Were these shoal places dredged vessels could come to the mills, thereby saving the $1 per 1,000, and affording besides a deep and safe fresh-water harbor.

S 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK OF DREDGE BOAT W. H. MOON, IN LAKE PONTCHARTRAIN, LOUISIANA.

Proposals for removing this wreck were invited, and contract was awarded to Mr. William G. James, of New Orleans, the lowest bidder, in the sum of $490. The contract was dated December 16, 1893, and approved January 2, 1894.

Work was commenced on January 11 and completed on the 23d of same month.

The removal was accomplished by blowing up the craft with dynamite. Nothing of value was recovered from the wreck.

Abstract of proposals received for removing the wreck of the dredge boat W. H. Moon, in Lake Pontchartrain, Louisiana, opened at New Orleans, La., December 6, 1893, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Price bid.
1	E. A. Conrad, New Orleans, La	$848
2	Enoch Townsend, Somers Point, N. J	900
3	George Mayley, New Orleans, La	550
4	John Hogan, Mobile, Ala	1,600
5	Usner & Dawson, New Orleans, La	800
6	William G. James, New Orleans, La	490

WRECK OF TWO STEAMBOATS IN THE GRAND RIVER AND PIGEON BAYOU ROUTES, LOUISIANA.

Bids were invited for removing one of these wrecks, the steamboat *G. W. Anderson*, in Grand River, Louisiana. The proposals were opened December 6, 1893, and Messrs. Usner & Dawson, of New Orleans, La., the lowest bidders, were awarded the contract for the sum of $650. The contract was entered into on December 15, and approved December 20, 1893.

The contractors commenced work on January 4. The wreck was blown up with dynamite and entirely removed from the channel by January 15, 1894. Nothing of value was recovered from the wreck.

The wreck of the other steamboat, the *E. H. Barmore*, in Big Pigeon Bayou, Louisiana, was taken from the channel by the owner without expense to the United States.

Abstract of proposals received for removing the wreck of the steamboat G. W. Anderson in Grand River, Louisiana, opened at New Orleans, La., December 6, 1893, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Price bid.
1	Johnston & Townsend, Somers Point, N. J	$895.00
2	Interstate Transportation Co., New Orleans, La	1,100.50
3	Usner & Dawson, New Orleans, La	650.00
4	William G. James, New Orleans, La	1,950.00

WRECK OR OBSTRUCTION IN SHIP ISLAND HARBOR, MISSISSIPPI SOUND.

Authority having been obtained for removing this obstruction, proposals were invited for doing the work and opened December 6, 1893.

Messrs. Johnston & Townsend, of Somers Point, N. J., were the lowest bidders, and were awarded the contract for the sum of $895. Contract was dated December 28, 1893, and approved January 6, 1894.

The work was commenced on January 10 by blowing up the obstruction with dynamite, and the entire work was completed on January 25, 1894. Nothing of value was recovered from the wreck.

Abstract of proposals received for removing a wreck or obstruction of similar character in Ship Island Harbor, Mississippi Sound, opened at New Orleans, La., December 6, 1893, by Maj. James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Price bid.
1	E. A. Conrad, New Orleans, La	$1,620
2	Johnston & Townsend, Somers Point, N. J	895
3	H. C. James, Biloxi, Miss	2,300
4	John Hogan, Mobile, Ala	1,900
5	Usner & Dawson, New Orleans, La	1,800
6	William G. James, New Orleans, La	2,475

APPENDIX T.

CURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

EPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 30, 1894.

GENERAL: I have the honor to submit the following report upon the works in charge of this office under the Chief of Engineers, U. S. Army, for the year ending June 30, 1894:

SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

This bayou was formerly an outflowing branch of the Mississippi River. It left the river at the town of Plaquemine, La., and after a course of about 10 miles began to branch off or divide into an intricate network of bayous, the whole system connecting with the Atchafalaya and Grand rivers and with Grand Lake.

While the bayou remained connected with the Mississippi it was leveed on both sides for some distance down. In 1865 the levee system on the west bank of the Mississippi was carried directly across the head of the bayou, cutting it off from all communication with the Mississippi.

By the river and harbor act of August 11, 1888, an appropriation was made for securing a navigable channel in this bayou up to the dike at Plaquemine and for preventing further caving of the bank of the Mississippi at the "mouth" (head) of the bayou, to secure the site of the locks which are to be built for opening navigable communication between the Mississippi and the bayou.

The work of bank protection was placed in charge of this office by letter of May 15, 1889, from the Chief of Engineers, U. S. Army.

The plant belonging to the general works of improvement in the fourth district, Mississippi River, of which this office has also charge, was thus rendered available for the Plaquemine work at such time as it is not required elsewhere.

Up to the date of the last annual report the project under which the work had been prosecuted contemplated the construction of a series of spur dikes normal to the bank line, placed at intervals of 700 to 1,200 feet along the caving bank. These dikes are about 400 feet long and 150 feet wide, and are built of brush and stone on a similar plan to that formerly employed for the works of bank protection in New Orleans Harbor.

At date of last annual report 5 of these dikes had been completed, 3 above the entrance to the proposed locks and 2 below, and 8,465 tons of rock for continuing the work was on hand, stored on the bank in the vicinity.

Caving between the dikes having continued, preparations were made to make certain repairs to the work during the low-water season of

1893, but this caving developed to such an extent that it became dent that effective repairs could not be made with the funds availa As in the case of a portion of the New Orleans Harbor work, it beca evident that detached spur dikes alone were not effective as a ba protection in this locality, and a project was therefore submitted constructing continuous revetment between the dikes with an estim for $72,000 in addition to the balance on hand.

This project was approved and the amount asked allotted. Un this project continuous revetment has been laid during the past sea which, with the spur dikes, forms a continuous protection 1,400 long below the site of the lock and 1,200 feet above, with an inter of 500 feet opposite the lock site, which is left for excavating the ne sary channel to the lock. The revetment has an average width about 400 feet.

The lumber for the work was procured by contract in New Orle and towed up by the Government tugs. Willows were cut and loa by hired labor at Tunica and at Lum's Landing on the Mississippi. rock required, except that already on hand, was obtained by cont and delivered on board Government barges at Memphis. It was q ried in Arkansas and sent to Memphis by rail. The towing was d by the steamer *General Newton.*

The work of sinking the mattresses began toward the lower end the revetment and progressed upstream. Caving continued at int vals throughout the low-water season and extended upstream unt reached a point about 600 feet above the upper terminus of the s son's work.

The total amount of revetment constructed during the season 899,500 square feet, at a field cost of a little over 10 cents per square f

Abstract of amounts allotted for this work.

May 18, 1889	$74
October 15, 1890	60
October 24, 1893	72
Total	206
Less reserved by Chief of Engineers for office-expenses:	
July 20, 1889	$170
July 17, 1890	83
Balance	205

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain, Corps of Engineer

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

NOTE.—The money statement for this work is consolidated with that for improvement of Bayou Plaquemine, Louisiana, Appendix S 6.

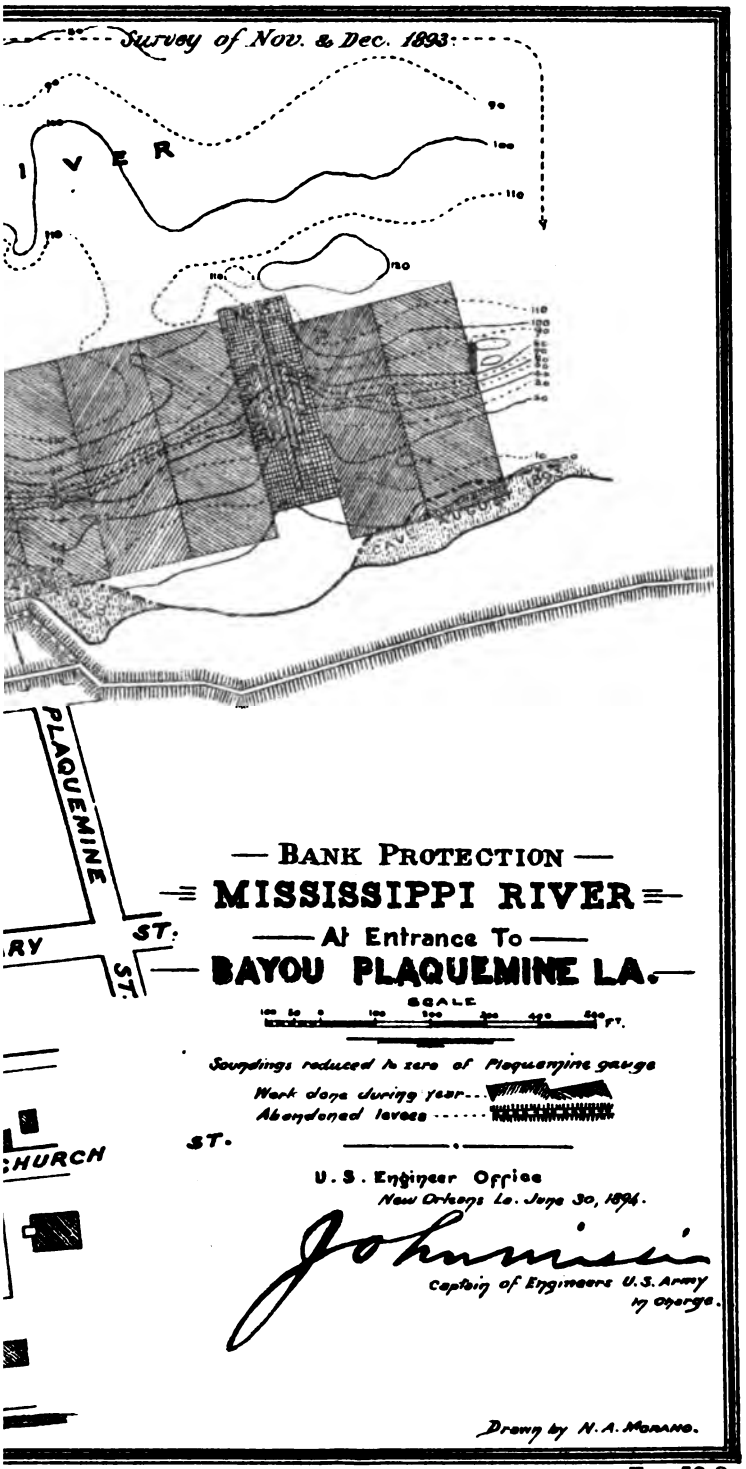
Assistant Engineer William Garvin, who was in local charge of work, reports as follows:

REPORT OF WILLIAM GARVIN, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *May 14, 189*

SIR: I have the honor to submit the following report on bank protection, imp ing Bayou Plaquemine, La.:

On August 14, 1893, I was relieved from duty at the depot in New Orleans, directed to take charge of the bank protection at Plaquemine, La., to commence *ting willows*, and to make a survey in the vicinity of the proposed repair wo *The quarter boat Gamma* was furnished with provisions and the necessary to


Survey of Nov. & Dec. 1893.
PLAQUEMINE
ST.
ST.
CHURCH
ST.
— BANK PROTECTION —
MISSISSIPPI RIVER
— At Entrance To —
BAYOU PLAQUEMINE LA.
SCALE
Soundings reduced to zero of Plaquemine gauge
Work done during year
Abandoned levees
U. S. Engineer Office
New Orleans La. June 30, 1894.
Captain of Engineers U.S. Army
in charge.
Drawn by N. A. Morano.

Eng. 53 3.

and with 3 barges, in tow of the tug *Tilda*, was started for the willow grounds on August 17. During the progress of the work at willow grounds the survey was completed at Plaquemine, all borrow pits and ponds in the vicinity of the dikes were drained. Mattress ways were built on the bank above Dike No. 1. The slope of these ways was about 6.5 feet horizontal to 1 vertical. They were built for holding 6 frames 100 feet long, or a capacity of 60 by 100 feet of completed mattress at each launch. In the month of November the ways were extended to top of natural bank to enable the same quantity of mattress to be constructed during the rising river. Eleven pieces of lumber 3 by 10 inches by 30 feet were purchased, and the remainder of the lumber used in constructing the ways was taken from the depot in New Orleans, it being lumber previously used on floating ways.

On October 6 the estimated quantity of willow, 2,922.88 cords, had been cut at Tunica Bar, and the quarter boat and barges towed to Plaquemine. Mattress construction was commenced on the morning of October 7.

In the early part of November the sum of $72,000 additional was allotted to this work, and the plans were modified to include the laying of continuous mattress revetment, from 300 feet below Dike No. 5 to 300 feet above Dike No. 2, leaving clear the bank line at entrance to lock. Early in November the work of cutting willows was resumed at Lums Bar, and the first barge load was received November 20. The supply of willows from Tunica Bar was exhausted and no mattress construction was done during the month of November until willows were received from Lums Bar. During the months of November and December a survey was made of the dikes not surveyed in September, and a part of work done in September was resurveyed extending over caves which occurred in December.

Owing to the late date at which the additional funds were allotted to this work, the loss of twenty days on construction, and the accident to first mattress below Dike No. 3, the revetment was not entirely completed. The following work has been completed in accordance with the project:

Two mattresses 150 by 400 by 2.5 feet were sunk below Dike No. 5, completing 300 feet of revetment. Three mattresses 150 by 400 by 2.5 feet, and 1 mattress 120 by 400 by 2.5 feet were sunk, covering the interval and completing the revetment between Dikes 4 and 5.

Two mattresses 150 by 400 by 2.5 feet were sunk above Dike 4, completing 300 feet of revetment extending from upper edge of foundation mattress of Dike 4 to space left clear at entrance to lock.

One mattress 150 by 400 by 2.5 feet and 1 mattress 150 by 490 by 2.5 feet, completing 300 feet of revetment, extending from lower edge of foundation mattress of Dike 3 to space left clear at entrance to lock.

Two mattresses 140 by 400 by 2.5 feet, two 150 by 300 by 2.5 feet, and one 120 by 300 by 2.5 feet were sunk between Dikes 2 and 3, forming 280 feet of completed and 420 feet of incomplete revetment. The 3 upper mattresses could not be sunk the required length, owing to the strong current and large quantities of driftwood flowing.

In addition, 1 mattress 150 by 400 by 2.5 feet was sunk below Dike No. 3. This was the first placed in position below Dike 3. In sinking, owing to the velocity of the current and immense accumulation of driftwood above the mooring and rock barges, the mooring wires, 1¼ inches in diameter, extending from mooring barge to bank, cut through the logs used as dead-men or moorings, the entire line of barges swung around, and the mattress was sunk almost parallel with bank line. It was replaced and forms no part in the general project, but is included in this report as one of the mattresses built and sunk. A total of 13 completed and 3 incomplete mattresses, containing 899,500 square feet, were built and sunk. The quantity and value of the material used in construction was as follows:

9,368 cords willow brush and poles	$18,303.98
138,469 feet, B. M., 3 by 6 inch and 2 by 4 inch lumber, at $9.35	1,294.69
286,499 feet, B. M., 3 by 6 inch and 2 by 4 inch lumber, at $8.70 per M	2,492.25
8,000 pounds 9-inch steel-wire spikes, at 2.25 cents per pound	180.00
4,000 pounds 9-inch steel-wire spikes, at 2½ cents per pound	100.00
200 pounds 9-inch steel-wire spikes, at 2.4 cents per pound	4.80
14,000 pounds 6-inch steel-wire spikes, at 1.53 cents per pound	217.00
5,200 pounds 6-inch steel-wire spikes, at 1.8 cents per pound	93.60
500 pounds 3½-inch steel-wire spikes, at 2 cents per pound	10.00
900 pounds 3½-inch steel-wire spikes, at 2.4 cents per pound	21.60
500 pounds 4½-inch steel-wire spikes, at 1.8 cents per pound	9.00
500 pounds 4½-inch steel-wire spikes, at 1.85 cents per pound	9.25
2,391 pounds No. 10 wire, at 2¼ cents per pound	53.79
7,487 pounds No. 10 wire, at 1.875 cents per pound	140.38
5,046 tons rock, at $1.45 per ton	7,316.70
6,719 tons rock, at $3.17 per ton	21,299.23
Total	51,546.27

Mattress	cubic feet..	2,248,750
Mattress	square feet..	899,500
Rock, per square foot to sink	pounds..	26.1589+

The manner of constructing and sinking the mattress was practically the same as followed in the New Orleans Harbor and described in previous reports.

The first mattress was sunk on November 7, 1893, and the last on February 24, 1894, when the river had attained the height of 24.3 on the Plaquemine gauge.

Five thousand and forty-six tons of rock was purchased at Memphis, Tenn., and 6,719 was loaded from the bank opposite Plaquemine. All lumber, wire, and nails used on construction were purchased in New Orleans. The total cost of the work at Plaquemine was as follows:

Preparing quarter boat and barges, loading and unloading lumber at depot, New Orleans	$248.33
Constructing mattress ways	167.35
Supervision	1,893.33
Subsistence	9,652.76
Care of plant	1,826.56
Tug *Tilda*, salary of crew, fuel, and material	2,271.34
Tug *General Comstock*	3,281.39
Willow, brush, and poles	18,303.98
Rock *	28,615.93
Lumber	3,786.94
Nails, wire, and other material	912.92
Labor	19,102.83
Total	90,063.66

The cost of mattress per square foot in place was $0.100126+; this is $0.01093 more than the cost of the work in the Southport end in the last season worked there. The additional cost is due mainly to the additional quantity and cost of the rock used, the cost of 543 cords of willows lost in towing, and owing to the strong current and driftwood along this bank, the additional care taken in constructing, poling, and wiring the mattresses.

Other expenditures were as follows:

Surveys	$253.51
Drains	211.96
Amount not charged to construction	465.47
Amount charged to construction	90,063.66
Total expenditure at Plaquemine	90,529.13

The quantity and value of material on hand when work was suspended was as follows:

16,200 pounds 6-inch wire nails, at 1.6 cents per pound	$259.20
7,800 pounds 9-inch wire nails, at 2.40 cents per pound	187.20
500 pounds 3-inch wire nails, at 2.05 cents per pound	10.25
4,592 pounds No. 10 wire, at 1.875 cents per pound	86.10
61,161 feet, B. M., 3 by 6 inch lumber, at $8.70 per M	532.10
140,327 feet, B. M., 2 by 4 inch lumber, at $8.70 per M	1,220.84
Total	2,295.69

The mattress necessary to complete the revetment between Dikes 2 and 3, will be, one mattress 100 by 150 feet, one 200 by 150 feet, and one 120 by 200 feet, a total of 69,000 square feet. On March 1 all lumber and other material had been loaded on barges, all lines collected and coiled, and the entire plant put in condition to be taken to laying-up quarters.

Very respectfully, your obedient servant,

WILLIAM GARVIN,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

* The cost of steamer *General Newton* towing rock from Memphis to Plaquemine has not been included in cost of rock.

APPENDIX U.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN TEXAS.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship Channel in Galveston Bay, Texas.
3. Channel in West Galveston Bay, Texas.
4. Trinity River, Texas.
5. Cedar Bayou, Texas.
6. Buffalo Bayou, Texas.
7. Harbor at Brazos Santiago, Tex.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 7, 1894.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

U 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

The project for this improvement was adopted in 1874, modified in 1880, and again modified in 1886, the object being to deepen the channel so as to admit of seagoing vessels of the deepest draft to enter the harbor.

The projects of 1874 and 1880 contemplated construction of two jetties to extend into the Gulf of Mexico to concentrate ebb flow upon the outer bar in the Gulf, and also to effect deepening on the inner bar at the entrance to Galveston Channel, these jetties to have their origins, respectively, at Bolivar Point and Fort Point.

More or less work was done under these projects. Under that 1881 a jetty was built from Fort Point to the crest of the outer b but it was not fully completed.

The project of 1886 (that now in progress of execution) also consi in construction of jetties to extend into the Gulf, one, the south jet starting from the east end of Galveston Island, and the other, north jetty, to start from Bolivar Point, opposite; or, to be more exa the south jetty was to start from Fort Point, but in 1888 it was deci to connect the inner end of that jetty with the relatively high grou upon which the city of Galveston is built by a stone dike known the shore branch.

The jetties were to be of stone, to be built to an elevation of 5 f above mean low tide, and to extend, if necessary, to the contour 30-foot depth in the Gulf, their sea ends to be 7,000 feet apart, action of the jetties to be supplemented, if need be, by dredging, south jetty to follow the line of the jetty of 1881.

The natural depth upon the outer bar was 12 feet and that upon inner bar 13 feet at mean low tide. The general plan of the work shown upon the accompanying map.

At the close of the fiscal year ending June 30, 1893, the progress ma in the construction of the jetties was as follows:

The south jetty had been completed for a distance of 32,000 feet a an apron, 829 feet long, was constructed at the sea end to prevent sco This jetty having reached the outer crest of the bar, its further ext sion was suspended for the present.

The north jetty, commenced in April, 1893, had been completed fo distance of 1,500 feet, in addition to which 2,100 feet had been partia constructed.

The effect of this work was plainly shown on the bars, the inner o having entirely disappeared and the depth on the outer one havi increased from 12 to 14 feet, a gain of 2 feet.

The construction of the north jetty was continued during the pres fiscal year and good progress was made, it having been completed a distance of 10,000 feet, an advance of 8,500 feet since last year, addition to which 6,200 feet was partially constructed. The sea end this jetty is now within 5,000 feet of the outer crest of the bar.

The total length of the jetties constructed since work was begun 1887 is:

	Linear
South jetty, completed	32,
South jetty, uncompleted	
North jetty, completed	10,
North jetty, uncompleted	6,
Total June 30, 1894	49,

An account in detail of the season's operations is shown in t accompanying report of Mr. E. M. Hartrick, assistant engineer, to wh attention is invited.

The usual annual survey of the bar and channel, as well as of t harbor generally, was made in May and June, 1894. The soundin show a channel depth of 14½ feet on the outer bar. The effect of t north jetty is now beginning to manifest itself. The bar is being wo away and is very irregular in contour, showing many holes and lump the 12-foot contour has moved northward and embraces a much less ar on the bar.

Galveston Channel has deepened and now has a maximum depth 41¼ feet. The depth on the inner bar is 24¼ feet, an increase of 1¼ fe

MADE UNDER THE DIRECTION OF

ER CORPS OF ENG'RS. U. S. A.

BY

IARTRICK, ASS'T. ENG'R.

&

WILCOX, ASS'T ENG'R.

IN MAY & JUNE 1894

THE FORSTERVILLE CO., PHOTO-LITH., BALTO., MD. Eng. 58 S.

since last year. The 24-foot curve now connects Galveston and Bolivar channels.

The principal changes in the position of contours since June 30, 1893, are shown on the accompanying map, on which the soundings are reduced to the plane of mean low tide, and are as follows:

The 18-foot curve inside the bar advanced 3,200 feet toward the same curve outside. The 12-foot curve on the bar advanced about 500 feet and the same curve south of south jetty receded about 300 feet. The 18 and 24 foot curves outside the bar advanced about 500 and 400 feet, respectively.

The steam propeller contracted for during the previous fiscal year was completed and delivered at Galveston on April 13, 1894.

Amount expended under all projects to June 30, 1893	$3,359,639.82
Amount expended during fiscal year ending June 30, 1894	1,008,824.68
Total expended to June 30, 1894	4,368,464.50

In addition to which the sum of $100,000 subscribed by the city of Galveston in 1883 was expended.

The work is located in the collection district of Galveston. The nearest lighthouses are at Bolivar Point and Fort Point, at the entrance to Galveston Bay.

Abstract of appropriations made by Congress for improving harbor at Galveston, Tex.

By act of—		By act of—	
July 11, 1870	$25,000	March 4, 1882	$100,000
March 3, 1871	20,000	August 2, 1882	300,000
June 10, 1872	31,000	August 5, 1886	300,000
June 23, 1874	60,000	August 11, 1888	500,000
March 3, 1875	150,000	September 19, 1890	500,000
August 14, 1876	142,000	March 3, 1891	600,000
June 7, 1878	75,000	August 5, 1892	450,000
June 18, 1878	50,000	March 3, 1893	1,000,000
March 3, 1879	100,000		
June 14, 1880	175,000	Total	4,828,000
March 3, 1881	250,000		

Money statement.

July 1, 1893, balance unexpended		$1,468,478.18
June 30, 1894, amount expended during fiscal year		1,008,824.68
July 1, 1894, balance unexpended		459,653.50
July 1, 1894, outstanding liabilities	$222,164.00	
July 1, 1894, amount covered by uncompleted contracts	222,662.94	
		444,826.94
July 1, 1894, balance available		14,826.56
Amount (estimated) required for completion of existing project		3,650,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations for improving Galveston Harbor, Texas, during the fiscal year ending June 30, 1894:

Condition of work at beginning of fiscal year.—South jetty was complete to Station 330, with a riprap apron to Station 328 + 39.

North jetty was complete to Station 15, with an incomplete portion, including apron of 2,100 feet, to Station 36. Trestle and track were at Station 38.

Casualties.—The weather and sea were more or less favorable, together with the protection afforded by south jetty, for the prosecution of the work on north jetty, but the lack of protection previously afforded by south jetty as the work advanced toward the Gulf, and the increased strength of tidal currents, cause a discontinuance of pile-driving and increase the difficulty of handling floating derricks and maneuvering barges and tows, under conditions of weather and sea which were not encountered close to shore.

During the equinoctial gales of March, 1894, also at other times strong winds from the northeast and easterly quadrants, accompanied with high tides, caused heavy seas to wash the small riprap from the crest for distances of several hundred feet in places where, from want of time or stress of weather, it had been impossible to promptly protect the crest with granite blocks.

During a thick fog on the 10th of March, 1894, a steamship ran into and carried away jetty beacon, which marked the end of south jetty. The caps and stringers between Station 327 and 328 + 39 were also carried away, leaving a few piles and partly submerged rails. A new beacon has been erected farther out on the axis of the jetty, 35 feet from the old one.

South jetty track.—The portion of south jetty from Station 0 to 81 + 28, was put in thorough repair during May, 1894. Over this section of the track nearly all of the stone for both jetties has been hauled.

The rails were removed, the caps and stringers properly underpinned and shimmed, and where necessary the riprap mound leveled off to receive cross-ties which were drift-bolted to stringer; the rail was then relaid and properly spiked to tie. From the end of these repairs to Fort Point Light-House, abreast of Station 108, the track is in fairly good condition for storing and switching empty cars that accumulate from Bolivar, but farther gulfward the piling is so worm-eaten that it is dangerous to run a locomotive over the trestle and track, the deterioration being rapid when not in constant use and undergoing repairs.

Inspection and construction.—In July, 1893, the inspector's office, railway track scales, and scale house at Bolivar were completed and the inspection and weighing transferred to Bolivar from Fort Point. But owing to poor transportation facilities from Galveston to Bolivar and return, and the contractor's inability to have the Government employés and inspectors on the work at the proper time, quarters were provided alongside the inspector's office, in which the Government inspectors and employés took up their abode in September, 1893. The general method of inspection and construction remains the same as explained in previous annual reports. (Appendix U, Annual Reports, Chief of Engineers, 1892 and 1893.

Transfer and barge line.—The transfer of riprap from Fort Point to Bolivar remains the same as explained in above reports. On the arrival of the contractor's tug *Hortense*, in August, 1893, a barge line was established between Clinton, in Harris County, on Buffalo Bayou, and north jetty, Bolivar, Galveston County. The barge line so far has only handled granite blocks. The weight of the granite was computed from displacement of barges, but this becoming unsatisfactory the present arrangement has been inaugurated, and is as follows:

The stone is delivered at Clinton yards on cars and weighed by a Government inspector on standard railway track scales, put up by the Government at that place in May, 1894. After being weighed the cars are run on a siding, close enough to the bayou bank to enable a steam derrick to transfer with facility the blocks from cars to barge. Another inspector keeps the number of blocks on each car with the car's number and initial; also number of cars on each barge and name of each barge, noting any blocks that may be lost overboard. This information is forwarded to the Galveston office. The weigher's report is also forwarded with car number, initial, weight, and number of blocks on a car.

As soon as the barges are loaded they are towed from Clinton down Buffalo Bayou, San Jacinto River, through Morgan Canal and Cut, ship channel, Galveston Bay, to north jetty, Bolivar. On their arrival off Bolivar transfer wharf, the barges are measured while loaded for displacement. They are then towed to the front and unloaded by a floating derrick which handles and transfers block by block from barge to riprap mound. The size and quality of the block and the loss occasioned by the carelessness of the derrick gang or faulty mechanical appliances are noted by an inspector. As soon as the barge is unloaded it is measured light for displacement. The weight of stone is then computed from the measurements taken on the barge, loaded and unloaded. The tonnage thus determined from displacement is forwarded to Galveston to be compared with the Clinton tonnage from track scales.

The barge line started with three barges in August, 1893; another was added in September, 1893, and a fourth, with a water barge, in December, 1893; in all, five stone barges, one transfer barge, one water barge, tended by two tugs with double crews, towing and transferring, and when necessary working night and day.

stone barges have a capacity of 750 tons, but are loaded to only 570 to 650 tons, ding to the depth of water in Buffalo Bayou. All the granite for the north has been transported by the barge line, except 771 cars, which were trans- l through Galveston and unloaded from trestle to relieve the accumulation at ton yards.

ieral progress and advance of the work.—The first half of the fiscal year the work etarded by lack of material, water for steam purposes, and floating tonnage, by the addition of two more stone barges and one water barge the capacity rning was increased to $90,000 per month. The earning capacity can be fur- increased to $120,000 per month by the assistance of another floating derrick or contrivance to place block and keep the completed portion of the jetty within nable distance of the incompleted work. At present for want of another der- the completed portion is 6,200 feet behind the incompleted. In an engineering of view this is no detriment to the work, as it allows consolidation, flattening lope, and settlement of the riprap mound before the addition of the granite- covering and protection.

ndition of the work.—The condition of the work on the north jetty at the end ie fiscal year was as follows: Jetty completed to Station 100, an advance of feet; riprap mound protected with granite block at Station 120; riprap mound ean low tide and partially protected with granite block at Station 125; trestle, k, and apron at Station 162, an advance of 12,600 feet.

NORTH JETTY.

TABLE No. 1.—*Showing kind and amount of stone placed in north jetty.*

Month.	Cars.	Riprap.	Cars.	Block.	Total cars.
1893.		*Tons.*		*Tons.*	
	1,011	21,264.12	282	6,086.53	1,293
ist	758	16,350.90	232	5,879.40	990
mber	814	18,496.61	376	9,381.01	1,190
ber	942	20,890.26	254	6,646.07	1,196
mber	860	19,908.61	268	6,814.98	1,128
ober	872	20,352.58	289	7,409.02	1,161
1894.					
ary	1,036	25,623.08	339	8,682.08	1,375
ary	414	10,739.08	453	11,543.03	867
	425	10,420.40	300	7,626.43	725
	810	19,705.49	398	9,062.38	1,208
	878	21,358.72	572	13,100.66	1,450
	1,320	30,087.62	408	9,730.53	1,728
Total	10,140	235,197.47	4,171	101,962.12	14,311

TABLE No. 2.—*Showing average cost per linear foot between stations.*

[Cost does not include office and inspection expenses.]

Stations.	Distance.	Depth of water.		Cost per linear foot.	Remarks.
		Max.	Min.		
	Feet.	*Feet.*	*Feet.*		
	1,500			$15.53	Shore branch.
0	500	8.0	0.5	35.68	Granite on crest; none on slope.
0	1,000	11.0	7.5	67.65	Granite on crest and on slope from station 24.
0	1,000	11.5	9.0	69.60	
0	1,000	11.5	9.5	71.27	
0	1,000	11.5	6.5	66.53	
0	1,000	8.0	5.0	70.06	Quicksand reef.
0	1,000	9.0	6.5	76.51	
0	1,000	12.5	9.0	100.96	
100	1,000	15.0	11.0	113.34	
110	1,000	19.0	15.0	124.75	Granite unloaded but not placed.
120	1,000	18.0	16.25	126.88	

SOUTH JETTY.

TABLE NO. 3.—*Showing average cost per linear foot between stations.*

[Cost does not include office and inspection expenses.]

Stations.	Distance.	Average depth of water.	Cost per linear foot.	Remarks.
	Feet.	*Feet.*		
0 to 79+64	7,964		$19.44	Shore connection across old channel; average height, 1.07 feet above mean low tide.
79+64 to 84+64	500	3.00	32.73	
84+64 to 95+64	1,100	2.45	26.40	
95+64 to 107+64	1,200	1.50	34.37	Clay core.
107+64 to 138+64	3,100	5.70	69.77	Do.
138+64 to 144+12	548	9.50	71.39	Do.
144+12 to 150	588	7.50	58.40	
150 to 160	1,000	7.30	54.64	
160 to 170	1,000	8.65	53.82	
170 to 180	1,000	7.00	38.68	
180 to 190	1,000	7.50	41.93	
190 to 200	1,000	10.95	77.88	Granite protection from Station 194.
200 to 210	1,000	10.35	79.28	
210 to 220	1,000	9.60	74.04	
220 to 230	1,000	7.00	70.62	
230 to 240	1,000	8.70	74.74	
240 to 250	1,000	9.00	78.58	
250 to 260	1,000	9.30	80.88	
260 to 270	1,000	10.20	87.84	
270 to 280	1,000	9.10	78.04	
280 to 290	1,000	9.20	72.19	
290 to 300	1,000	9.10	76.44	
300 to 310	1,000	10.10	76.87	End of mattress.
310 to 320	1,000	16.50	128.22	Sand foundation.
320* to 328+39	839	15.10	24.93	839 feet of apron.

*Apron about 5 feet thick and 35 feet wide; all riprap, no granite.

Annual survey.—The annual survey was commenced in May and completed in June, 1894. Levels were taken over the axis of south jetty every 7½ feet from Station 80 to Station 320. Compared with the profile made in June, 1893, there is a slight consolidation over the whole jetty, the last 300 feet in the gulf showing a settlement of about 1 foot. The apron also has settled and consolidated and has now more or less sand over its extreme end. The clay core section, between stations 95 and 114 is still undergoing a marked consolidation. The shore branch from Station 0 to Station 80 having been leveled off to receive railway cross-ties, there can be no comparison made with last report over this portion of the jetty; but comparing the levels taken in November, 1893, with those made in June 1893, no settlement was observed, and as there has been no storm or overflow the presumption is that it remains practically the same to this date. Water cross sections were taken 500 feet apart and 100 feet out on both sides of the jetty from Station 100 to the end of the work. On plotting and comparing with last year's cross sections there appears a general accretion on both sides, the north side showing a banking of sand against the jetty varying from 1 to 8 feet between stations 160 and 240, and on the south from one-fourth to 5 feet between stations 130 and 180. This accretion, as far as can be observed, fills the interstices of the riprap mound, making it practically water-tight at mean low tide as far out as Station 110.

In the immediate vicinity of south jetty apron, on the north side, the depth of water has increased from 1 to 4 feet, the maximum depth being near the toe of the slope.

Over the completed portion of north jetty levels were taken along the axis, and cross sections every 100 feet and 100 feet out from axis. These sections, compared with sections taken from month to month as the work progressed, show a consolidation or settlement averaging three-fourths of a foot from Station 15 to Station 70, with a maximum of 1½ feet between stations 30 and 50, where soft bottom was encountered. The settlement in other portions of the work may be partly accounted for by the nature of the bottom, which is more or less of a quicksand character.

Galveston Channel has deepened, and has a maximum depth of 41½ feet between Red and Black beacons.

The inner bar has a navigable channel depth of 24½ feet, an increase of 1 foot in twelve months; the 24-foot curve now connects Galveston Channel with Bolivar Roads.

The shoal between Buoys Nos. 3 and 5 and south jetty has receded toward Fort

Point, off Buoy No. 5, and moved forward toward Buoy No. 3. The extreme end of this shoal inside the 12-foot curve has worn away, giving a greater depth of water. The curves of depth around Bird Island Shoal remains about the same, except in the immediate vicinity of north jetty, where the shoal has been cut through on both sides of the jetty. That part of the shoal remaining east of the jetty is wearing away, the sand being deposited in the angle formed by the jetty and Boliver shore. The channel between Bird Island Shoal and Bolivar is filling up and the shore line advancing at the root of the jetty.

The outer bar between the lines of proposed jetty extension is wearing away near south jetty, and the deep-water curves inside the bar are approaching the curves in the gulf, so much so that the 18-foot curve in East Channel has advanced toward the 18-foot outside over 3,200 feet. Near north jetty the 18 and 24 foot curves outside have advanced, but only about one-sixth to one-eighth of the distance gained by the inside. The 12-foot curve on the bar has advanced about 500 feet, and the same curve south of south jetty has receded about 300 feet.

The southeast channel as north jetty is extended fills up, and a new channel forms farther gulfward, but before the new channel has time to scour to a greater depth the same filling process is repeated, leaving knolls and holes, so that there is only a navigable depth of a good 14 feet, but this 14 feet can be carried over a channel from 670 to 1,800 feet wide, with 14½ feet in a more tortuous channel from 300 to 500 feet wide.

A few lines of soundings were run between the 30 and 40-foot curves in the Gulf of Mexico, but owing to unfavorable weather the data is not complete enough to forward with this report.

The erosion along the beach south of First street on Galveston Island continues, and the accretion north of same street is advancing gulfward, but in a greater proportion.

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF GALVESTON HARBOR, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1894.

Tonnage of vessels and revenue collected.

Steam vessels entered	295
Sailing vessels entered	165
Total	460
Steam vessels cleared	252
Sailing vessels cleared	141
Total	393
Total tonnage of vessels entered	524,789
Total tonnage of vessels cleared	462,487
Total tonnage	987,276
Duties on imports collected	$73,332.66

Amount and value of freight shipped.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton (1,027,367 bales)	239,183	$37,504,000	$2,796,000
Cotton products	80,474	1,690,000	402,000
Ore	531	124,000	3,000
Wool	5,542	1,241,000	77,000
Grain	10,949	224,000	43,000
General merchandise	18,000	3,220,000	160,000
Total	354,679	44,003,000	3,481,000

Decrease of freight carried over last year, 15,569 tons.

Comparative statement of commercial statistics of the port of Galveston, Tex., for fiscal years 1890 to 1894.

Year.	Vessels entered.		Vessels cleared.		Tonnage.		Total.
	Steam.	Sailing.	Steam.	Sailing.	Entered.	Cleared.	
1890	302	145	304	118	501,695	492,677	994,372
1891	242	139	345	96	544,862	529,058	1,073,920
1892	345	137	342	62	587,216	547,110	1,134,326
1893	300	114	295	36	497,150	489,563	986,713
1894	295	165	252	141	524,780	462,487	987,276

Transported.

Year.	Cotton.	Cotton products.	Corn and wheat.	Ore.	Wool.	General merchandise.	Total weight.	Total value.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
1890	223,486	79,140	.....	.....	6,883	.....	309,509	$51,558,115
1891	258,638	44,182	.....	6,923	6,847	14,028	330,618	59,634,000
1892	287,377	62,114	23,068	8,100	6,974	5,778	393,411	51,260,000
1893	242,515	82,808	36,330	1,418	3,832	3,345	370,248	51,250,000
1894	239,183	80,474	10,949	531	5,542	18,000	354,679	44,003,000

U 2.

IMPROVEMENT OF SHIP CHANNEL IN GALVESTON BAY, TEXAS.

A project for this improvement was adopted in 1871 and modified in 1877; a subsequent modification became necessary in 1892, owing to the acquisition by the United States of the Morgan Cut and Canal, formerly owned by the Buffalo Bayou Ship-Channel Company, together with its charter and rights under it. The cut and canal extends from the end of the ship channel in Galveston Bay through Morgan Point to the San Jacinto River, a distance of 5.4 miles, and is now considered part of the ship channel proper.

The project as modified in 1892 consists in excavating a channel, at least 100 feet wide and 12 feet deep, from Bolivar Channel through Galveston Bay and the Morgan Cut and Canal to the San Jacinto River, a distance of 24.33 miles, the ruling depth from Bolivar Channel to Morgan Beacon (18.9 miles) being 8½ feet, that from Morgan Beacon to Morgan Canal (4.8 miles) being 7½ feet, and the depth through the canal (0.63 mile) being 17 feet.

This work is one link in a waterway connecting Houston with the Gulf of Mexico, the other links being the San Jacinto River and Buffalo Bayou.

The estimated cost of the ship-channel improvement, as revised in 1892, was $896,175.44, in connection with which it was stated that it would require an annual appropriation of $100,000 to maintain the channel after it was completed. Dredging was carried on under appropriations made from 1875 to 1888, and a channel of the desired width and depth had been excavated from Bolivar Channel to the Morgan Cut by July, 1889, but as no work was carried on from then until the end of the last fiscal year the channel had shoaled to 8 feet.

The work of the fiscal year consisted of dredging, repairing of beacons, and in the erection of a fence around the Government reservation at Morgans Point.

Dredging under the contract with the Rittenhouse Moore Dredging Company, entered into during the previous fiscal year, began July 17,

1893. The work was considerably delayed by the breaking down of the dredge, the lack of sufficient scows to transport material, and bad weather. On April 26, 1894, the contractors replaced the old with a new plant, but this one also broke down on May 10, causing a loss of twenty-eight days' time. These combined causes prevented the completion of the work before the end of the fiscal year.

The channel was dredged between the Morgan Beacon and the Morgan Canal, a distance of 4.8 miles, the location being practically the same as the old Morgan Cut which connected the ship channel with the canal. The length of the completed work was 19,000 linear feet, of which 4,000 feet was 100 feet wide and 15,000 feet was 75 feet wide, all of it being 9.5 feet deep at mean low tide. The total amount of material removed was 153,376 cubic yards.

This work has increased the average depth of water for navigation from 8 to 9.5 feet, an increase of 1.5 feet. There is now an average depth of water of 9.5 feet from Bolivar Channel to the Morgan Canal.

The details of the season's operations are shown in the report of Mr. Donald Allen, assistant engineer, which is forwarded herewith.

It is not practicable to give the statistics of the commerce of the ship channel. Almost the entire floating commerce of Buffalo Bayou, Trinity River, and Cedar Bayou is carried through this channel, and the commercial statistics are given in the reports for those works. The number of vessels passing through Morgan Canal during the year was 1,979, of which 1,109 were northbound and 870 were southbound.

It is believed by many of the best informed men of Houston that the advantages to be derived from enabling seagoing ships to reach Houston by way of the ship channel and Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. The annual report of Buffalo Bayou gives as full statistics of the freight carried upon that stream as could be obtained. It is carried in barges drawing 5 feet when full loaded and towed by tugs drawing 7 feet and less. These cross Galveston Bay, but the depth of water is already sufficient for them. A large portion of this freight would be loaded directly upon seagoing vessels if they visited Houston. One item of shipment by water down Buffalo Bayou from Houston during the past fiscal year was 275,378 bales of cotton.

Total expended on this improvement to June 30, 1893	$557,315.80
Total expended during fiscal year ending June 30, 1894	40,332.78
Original estimated cost of this work as revised in 1892	896,175.44
Aggregate amount appropriated to July 1, 1894	626,500.00
Amount expended to July 1, 1894	597,648.58
The amount required for maintenance after the completion of the original excavation (annually)	100,000.00

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Bolivar Point, Fort Point, Half-Moon Shoal, and Redfish Bar.

Abstract of appropriations made by Congress for improving ship channel in Galveston Bay, Texas.

By act of—		By act of—	
March 3, 1875	$25,000	August 2, 1882	$94,500
August 4, 1876	72,000	August 11, 1888	100,000
June 18, 1878	75,000	September 19, 1890	40,000
March 3, 1879	80,000	July 13, 1892	40,000
June 14, 1880	50,000		
March 3, 1881	50,000	Total	626,500

The amount that can be profitably expended during the fiscal year ending June 30, 1896, is $200,000, to be applied to dredging.

Money statement.

July 1, 1893, balance unexpended		$69,184.20
June 30, 1894, amount expended during fiscal year		40,332.78
July 1, 1894, balance unexpended		28,851.42
July 1, 1894, outstanding liabilities	$8,031.66	
July 1, 1894, amount covered by uncompleted contracts	18,772.82	
		26,804.48
July 1, 1894, balance available		2,046.94
Amount (estimated) required for completion of existing project		269,675.44
Amount that can be profitably expended in fiscal year ending June 30, 1896		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations for the improvement of ship channel in Galveston Bay, Texas, for the fiscal year ending June 30, 1894:

The ruling depth from Bolivar Channel to Morgan Beacon is 8.5 feet and the average depth 9.5 feet, and from Morgan Beacon to Morgan Canal the ruling depth is 7.5 feet and the average 9.5 feet.

Through the canal the depth remains about the same as last year.

Dredging.—A contract for redredging Morgan Cut from Morgan Beacon to Morgan Canal was entered into with the Rittenhouse Moore Dredging Company, of Mobile, Ala., March 21, 1893, work to commence April 25, 1893, and to be completed October 25, 1893. An extension of time to July 25, 1894, to complete the contract was granted contractors.

Dredging was not commenced at Morgan Beacon until July 17, 1893, as contractor's plant encountered a gale in the gulf on the way from Apalachicola to Galveston, losing one scow and damaging the dredge.

After work commenced much time was lost on account of having only one scow and the breaking down of plant. January 4, 1894, contractors secured a second scow.

On March 19, 1894, in a very severe gale, both scows were blown ashore "high and dry" west of Morgan Canal, and a channel had to be dredged to them to get them off. They were gotten afloat April 5, 1894, but had to go on the ways for repairs. Dredging was resumed on April 26, 1894, with a new plant, the old plant having been found insufficient for the work. The new plant lost twenty-eight days between May 10 and June 7, 1894, on account of dredge breaking down.

The total amount of material dredged from Morgan Cut at the close of the fiscal year, June 30, 1894, was 153,376.22 cubic yards.

Total length of completed channel, 19,000 linear feet (4,000 linear feet 100 feet wide and 15,000 linear feet 75 feet wide), all of it 9½ feet deep at mean low tide.

There remains 5,800 linear feet of channel to be dredged to reach the 9½-foot depth at the mouth of Morgan Canal.

Cut at Redfish Bar.—From a survey made in December, 1893, of the cut at Redfish Bar, it was ascertained that the reefs were not making out into the channel, as complained, on the west side of the cut and north of the bar, and that boats getting aground in this vicinity was due to their being entirely outside of the limits of the dredged channel.

Fence at Morgans Point.—During August, 1893, a fence protecting the right of way on both sides of Morgans Canal was completed, the total length of which is 5,120 feet.

* * * * * * *

The following material was used in building it:

4 by 6 inch 8-foot sawed cypress posts		505
1 by 6 inch 20-foot pine planks		300
Wire nails	pounds..	100
Galvanized steel staples	do....	150
Galvanized barbed steel wire	do....	1,450

Beacons.—During September, 1893, ship channel beacons (L. B. Nos. 2 to 16 inclusive, S. B. N. B. and Morgan Beacon) were repaired and repainted. Beacon No. 1, which had been knocked down by a boat, was raised and repaired April, 1894.

All beacons are in good shape at this date except No. 10, damaged by a boat running against it, but it is still standing, and No. 9 knocked down by a boat.

Tug Dorothy.—For safety of the boat and protection of the men and machinery in the open bay, it was found necessary to erect a pilot and boiler house on the tug *Dorothy* in July, 1893.

A brass condenser was put in, replacing an iron one rusted out, January, 1894, and the engine was thoroughly overhauled in April. The tug is in good order at this date.

Very respectfully, your obedient servant,

DONALD ALLEN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

U 3.

IMPROVEMENT OF CHANNEL IN WEST GALVESTON BAY, TEXAS.

West Bay is an expanse of water between Galveston Island and the mainland, and extends from Galveston Bay to the west end of Oyster Bay. It is connected with the Gulf of Mexico by San Luis Pass, having a depth of 7 to 8 feet, and with Brazos River by the Galveston and Brazos Canal, in which the depth has been dredged to 7 feet. The natural channel through the bay was crooked and narrow, and its depth varied from 2.5 to 5 feet.

A channel, having a navigable depth of 5 feet, was dredged through the bay in 1859 by the State of Texas; it had, however, shoaled to its original depth at the time a survey was made in 1891.

The project adopted for this improvement consisted in straightening and widening the channel to 200 feet and in deepening it so that 3.5 feet of water was available for vessels from the railroad bridges crossing the bay near Galveston to San Luis Pass. A channel 100 feet wide and 3 feet deep was also to be dredged along Christmas Point in Oyster Bay and beacons were to be erected in the bay so as to properly define the channel.

Work on this improvement was commenced January 19, 1893, a contract for dredging having been entered into with Mr. Branch T. Masterson, of Galveston, Tex. At the close of the last fiscal year but little progress had been made, owing to the insufficiency of the contractor's plant, which was constantly breaking down.

Dredging was continued under this contract during the present fiscal year, several extensions in time having been granted the contractor in which to complete the work, but this he had not done at the end of the fiscal year. A large amount of time was consumed in making repairs to his plant, so that the work accomplished was small. The channel across Deer Islands Reef had been nearly completed, only a small amount of work south of the islands being required to finish it.

The dimensions of the channel, so far as completed, are as follows: Length, 4,723 feet; width, 100 to 160 feet; depth, 3.5 feet; amount of material dredged, 8,327 cubic yards.

It is expected that the work at Deer Islands will be finished at an early date, when the contractor's plant will be set to work dredging a channel across Karonkaway Reef.

The details of the season's work are shown in the report of Mr. Donald Allen, assistant engineer, which is forwarded herewith.

Abstract of appropriations.

By act approved July 13, 1892 ..... $15,000

The sum of $14,000 can be profitably expended during the fiscal year ending June 30, 1896, in completing the work.

The work is located in the collection district of Galveston, Tex. The nearest light-houses are at Half-Moon Reef and Redfish Bar, in Galveston Bay, and at Bolivar and Fort Point, at entrance to Galveston Bay. There are life-saving stations at Fort Point and San Luis Pass.

Money statement.

July 1, 1893, balance unexpended		$12,682.29
June 30, 1894, amount expended during fiscal year		3,749.82
July 1, 1894, balance unexpended		8,932.47
July 1, 1894, outstanding liabilities	$489.47	
July 1, 1894, amount covered by uncompleted contracts	8,443.00	
		8,932.47
Amount (estimated) required for completion of existing project		14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		14,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations for the improvement of channel in West Galveston Bay, Texas, for the fiscal year ending June 30, 1894:

A contract for dredging was entered into October 17, 1892, and approved November 2, 1892, with Branch T. Masterson, of Galveston, Tex. Work to commence December 1, 1892, and to be completed March 31, 1893. An extension of time to July 31, 1893, was granted by the Department and further extension was granted in a letter, August 12, 1893, authorizing this office to treat the contract as still in force, retaining the right to annul it when considered expedient.

The progress of the work has been very slow, owing to the totally insufficient plant of the contractor, the machinery continually breaking down, and long periods being consumed in making repairs to the same.

The channel north of Deer Islands, between beacons A and B, was completed in April, 1894, the cut being 2,700 feet long, 160 feet wide, with a depth of 3.5 feet at mean low tide, the amount of material excavated being 7,069 cubic yards.

The channel between Deer Islands, between beacons B and C, was completed in May, 1894, the cut being 2,035 feet long, 100 feet wide, with a depth of 3.5 feet at mean low tide, the amount of material excavated being 1,258 cubic yards.

Making the total amount of work done during the fiscal year of completed channel: North of Deer Islands, A to B, 2,700 linear feet, 160 feet wide, 3.5 feet deep; between Deer Islands, B to C, 2,035 linear feet, 100 feet wide, 3.5 feet deep; total, 4,735 linear feet.

Excavated to make same:

	Cubic yards.
Between beacons A and B	7,069
Between beacons B and C	1,258
Total	8,327

Seven beacons, to mark the line of the dredged channel in the vicinity of Deer Islands, were erected in April, 1894. Four of them, A, B, C, and D, marking the points where the channel changed direction, are constructed of a single pine pile, 8 by 8 inches, 20 feet long, driven in the ground about 10 feet. The pile, to protect it from the ravages of the toredo, is encased in a cast-iron pipe, penetrating the ground not less than 3 feet and rising above mean low tide not less than 2 feet, and the annular

space between the pile and pipe is filled with hydraulic cement. The pile is surmounted by a signal pole and slatted ball 4 feet in diameter, which stands from 20 to 25 feet out of the water.

The intermediate range beacons, E, F, and G, are of the same construction, except the piles are not encased in the cast-iron pipe.

Very respectfully, your obedient servant,

DONALD ALLEN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF WEST GALVESTON BAY, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Vessels navigating the bay, 51 (5 steam vessels, 6 barges, and 40 sailing vessels); length, 20 to 141 feet; draft, 3 to 5 feet; tonnage, 3 to 240 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.
Cotton and cotton seed	6,500	$335,000
Lumber	760	14,000
Cattle	250	2,500
General merchandise	2,500	360,000
Total	10,010	711,500

Increase since last year, 5,113 tons.

Comparative statement of commercial statistics of West Galveston Bay, Texas, for fiscal years 1893 and 1894.

Year.	Vessels using bay.	Maximum length.	Maximum draft.	Maximum tonnage.	Freight transported.	Total value.
	No.	*Feet.*	*Feet.*	*Tons.*	*Tons.*	
1893	37	141	5	240	4,897	$622,477
1894	51	141	5	240	10,010	711,500

U 4.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

Trinity River empties, through several mouths or passes, into Galveston Bay near its northeast extremity, about 35 miles from Galveston. The relative importance of the passes appears to have varied considerably, the one generally used by vessels of late years being the Middle Pass. The depth in this pass is 9 feet or more, and in the river above 16 feet of water is found. Opposite each mouth is a bar, the depth on that of the middle pass being 3 feet 6 inches. The trade using the river is carried in sailing vessels which draw from 3 feet to 4 feet 8 inches, and in order to accommodate them there should be a channel from 5½ to 6 feet deep.

The project for this improvement contemplates the erection of 2 parallel jetties at the mouth of the middle pass, placed about 275 feet apart and extending 7,750 feet into Galveston Bay, also in closing the other passes by submerged dams.

Previous to the adoption of this project, a channel had been dredged and redredged across the bar, and 4,575 feet of east and west jetty had been constructed. Owing to suspension of operations and natural causes this channel, though not obliterated, had shoaled considerably, and of the revetment only 2,100 feet remained in good condition.

Subsequent appropriations were applied to extending the west jetty and at the close of the last fiscal year, the completed length of this jetty was 6,159 feet; of the east jetty 300 feet was still in good condition. The depth on the bar, however, remained practically the same, viz, 3½ feet at mean low tide.

In the project submitted for the expenditure of the amount ($10,000) appropriated by act of July 13, 1892, it was stated that as this amount was inadequate for the completion of the project, it was deemed better to apply the available funds to some method of immediate benefit to navigation. It was, therefore, recommended that the west jetty be extended about 1,200 feet, to a point where it would meet the 5-foot contour of the bay, and that a channel, 5 feet deep by 100 feet wide, be dredged connecting the inner and outer 5-foot contours. The extension of the jetty to be done by hired labor and purchase of material in open market and the dredging by contract.

This recommendation having been approved, bids were requested for furnishing the lumber, etc., required for the construction of the jetty, and the material was ordered on October 16, 1893. The first delivery of lumber was made November 3, 1893, but the shipment was not completed until February 16, 1894, owing to labor troubles at the mills. This detention prevented the commencement of the work until February 1, 1894, when a party, organized for that purpose, began the construction of the extension to the west jetty, which was completed April 6, 1894, 1,200 linear feet having been constructed at a cost of $4.34 per linear foot including inspection. The work was greatly retarded by stormy weather which also increased the cost of construction. The west jetty is now practically completed with a length of 7,359 feet.

On December 20, 1893, the dredging was advertised, and bids were opened on January 20, 1894, the lowest bidder being Charles Clarke & Co., of Galveston, Tex. A contract was entered into with them on February 12, 1894, to do the work which was to be completed May 15, 1894.

Dredging was commenced April 6 and finished April 23, 1894. A channel 1,200 feet long and 5 feet deep at mean low tide was dredged parallel to the new portion of the jetty and 20 feet east of it, and the channel along 1,000 feet of the old jetty was dredged along its eastern edge. The amount of material removed was 6,626 cubic yards, which was deposited behind the jetty.

This comprised the work of the fiscal year, and has resulted in an unobstructed channel over the bar, having a width of 100 feet and depth of 5 feet at mean low tide.

The details of the season's operations are shown in the report of Mr. Donald Allen, assistant engineer, which is forwarded herewith.

A special agent was employed during the year to keep a record of the commerce and tonnage of the river. Statistics compiled from his report are herewith.

Amount expended to June 30, 1893	$56,746.93
Amount expended during fiscal year	8,437.83
Total expended to June 30, 1894	65,184.76

Abstract of appropriations made by Congress for improving Trinity River, Texas.

By act of—	
June 18, 1878	$10,000
March 3, 1879	2,500
June 14, 1880	4,000
March 3, 1881	10,000
August 2, 1882	8,000
August 11, 1888	12,500
September 19, 1890	10,000
July 13, 1892	10,000
Total	67,000

The sum of $22,500 can be profitably expended during the fiscal year ending June 30, 1896, in completing the work.

The work is located in the collection district of Galveston. The nearest lighthouse is at Redfish Bar.

Money statement.

July 1, 1893, balance unexpended	$10,253.07
June 30, 1894, amount expended during fiscal year	8,437.83
July 1, 1894, balance unexpended	1,815.24
Amount (estimated) required for completion of existing project	22,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	22,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for dredging in Trinity River, Texas, received in response to advertisement dated December 20, 1893, and opened January 20, 1894, at Galveston, Tex., by Maj. A. M. Miller, Corps of Engineers.

No.	Name and address of bidder.	Dredging 10,000 cubic yards, more or less, per cubic yard.	Amount.
		Cents.	
1	Chas. Clarke and Robert P. Clarke, Galveston, Tex	32½	* $3,250
2	J. H. Hawley, Galveston, Tex	40	4,000

* Lowest bid; acceptance recommended.

REPORT OF MR. DONALD ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations for improving Trinity River, Texas, for the fiscal year ending June 30, 1894:

The project for the improvement, approved by the Department July 26, 1893, was to extend the west jetty 1,200 feet to the point where it would meet the 5-foot contour of the bay, and to dredge a channel 100 feet wide by 5 feet deep at mean low tide across the bar, connecting the inner and outer 5-foot contours; to construct the jetty by hired labor and to buy the material in the open market, it being considered most economical and advantageous to the Government, and do the dredging by contract.

October 10, 1893, bids were requested to furnish the lumber delivered at the mouth of Trinity River. October 16, 1893, the offer of the Lutcher and Moore Lumber Company, of Orange, Tex., to deliver the lumber at $13 per M, being the lowest, was accepted for immediate delivery. The iron work was let to the Astall Iron Works, of Galveston, their offer being the lowest.

The first schooner loaded with lumber arrived November 3, 1893, and the shipment was not completed until February 16, 1894, the delay in making prompt delivery being due to labor troubles at the mills. Owing to the nonarrival of the lumber, the work on the jetty could not be commenced until February 1, 1894. On this date there left Galveston for Trinity River on the schooner *Andrew Boden* a force consisting of 1 overseer, 1 engineer of pile-driver, 1 master pile-driver, 1 blacksmith, 3 carpenters, 4 laborers, 1 cook, total 12 men, going via Morgan's Point, where a quarter boat and a barge with steam pile-driver and blacksmith shop on it were taken in tow, arriving at the mouth of the Trinity River that evening.

On February 2, 1894, the jetty was commenced, and it was completed April 6, 1894. It commences at the south end of the old jetty and extends south to the 5-foot contour in the bay. It is 1,200 feet long, and cost $4.34 per linear foot for labor, material, and inspection. The material is sawed yellow heart pine, and it is constructed as follows:

A row of piles 12 by 12 inches, 24 feet long, is driven, 8 feet centers, with an average penetration of 16 feet, in the ground, and standing in an average depth of four feet of water. Tops of piles 4 feet 10 inches above mean low tide.

On the west or opposite side from the channel, and against the line of piling, two lines of stringer pieces, of 4 by 8 inches, 16 feet long, are placed to break joints; the bottom stringer 8 inches and the top stringer 3 feet 4 inches above mean low tide, respectively. Against these stringers the sheet piling, 3 by 12 inches, 20 feet long, are driven, their tops standing 4 feet 4 inches above mean low tide. Each sheet pile is spiked to the top stringer by two 6-inch boat spikes. These sheet piles have an average penetration of 12 feet in the ground.

On the outside of the sheet piling two lines of stringers, pieces 4 by 8 inches, 16 feet long, are placed opposite the two lines of stringers, which are against the piles, and the sheet piling between these stringers is held securely in place by inch bolts passing through both sets of stringers and piles.

On the channel or east side of the line of piling a fender, consisting of two pieces of 4 by 8 inches, 16 feet long, is spiked to the piles at a height of 2 feet above mean low tide for the entire length of the jetty.

There was used in the construction of the jetty the following material: 152 12 by 12 inch 24-foot yellow pine piles; 1,171 3 by 12 inch 20-foot yellow pine sheet piles; 4,800 linear feet 4 by 8 inch yellow pine stringers; 2,400 linear feet 4 by 8 inch yellow pine fenders; 304 bolts 1 inch diameter, 27 inches long, with 2 cast-iron O. G. washers to each bolt 1 inch thick by 3 inches in diameter.

In order to construct this work it was necessary to hire a barge with steam pile-driver and blacksmith shop on it, and a quarter boat for the force to live in, for which a compensation of $100 per month for the first and $75 per month for the second was paid, and a new skiff was bought at a cost of $58.40.

During the construction of the jetty (February 1 to April 6, 1894), owing to bad weather and very strong southerly winds, making the water too rough to work, followed by frequent severe northers leaving the pile-driver aground, for fully one-third of the time no work could be done between these dates, thus delaying its completion.

A very severe gale on the 19th of March sunk the pile-driver, and swept off into the marshes all of the loose timber, which was afterwards recovered. The pile-driver was sunk three times during the construction of the jetty.

On the 7th of April, 1894, the jetty having been completed, the force was transported to Galveston and paid off. On April 10, 1894, the pile-driver and quarter boat was towed to Morgans Point and returned to their owners in good order.

On December 20, 1893, the dredging was advertised, bids to be opened January 20, 1894.

Contract with Charles Clarke & Co. was entered into February 12, 1894, work to commence on or before February 15, 1894, and to be finished on or before May 15, 1894.

Dredging was commenced at the mouth of Middle Pass on April 6, 1894, by Charles Clarke & Co., and the work was completed on April 23, 1894.

A channel 1,200 feet long and 5 feet deep at mean low tide was dredged parallel to the new portion of the jetty and 20 feet east of it, and the channel along 1,000 feet of the old jetty was dredged along its eastern edge. The amount of material removed was 6,626 cubic yards; the material was deposited behind the jetty.

An unobstructed channel now exists over the bar, having a width of 100 feet and a depth of 5 feet at mean low tide.

Very respectfully, your obedient servant,

DONALD ALLEN,
U. S. Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Vessels using the river, 31 (30 sailing vessels and 1 steamer); length on deck, 29 to 130 feet; draft, 2.5 to 5 feet; tonnage, 4 to 90 tons; trips made during the year, 893; total tonnage, 11,732 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton	214	$19,584	$785
Lumber	7,050	25,334	6,814
General merchandise	418	23,354	1,401
Total	7,682	68,272	9,000

Decrease since last year, 1,624 tons.

Comparative statement of commercial statistics of Trinity River, Texas, for fiscal years 1888 to 1894.

Year.	Vessels using river.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	32	65	4.7	32	1,217	15,958
1889	36	65	4.5	32	1,330	16,737
1890	33	80	5.5	80	1,221	16,887
1891	30	80	5.5	80	1,115	15,733
1892	30	120	5.6	150	1,100	13,994
1893	32	150	5.6	150	1,115	15,641
1894	31	130	5.0	90	893	11,732

Transported.

Year.	Cotton.	Lumber.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*		
1888	226	11,863	855	12,944	$88,704	$17,067
1889	148	10,872	1,159	12,179	75,902	17,276
1890	102	10,906	719	11,727	46,347	14,249
1891	38	9,364	552	9,954	47,034	13,582
1892	37	8,753	794	9,584	61,810	13,049
1893	54	8,933	319	9,306	52,907	11,697
1894	214	7,050	418	7,682	68,272	9,000

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IMPROVEMENT OF CEDAR BAYOU, TEXAS.

Cedar Bayou discharges into the northwest corner of Galveston Bay, at a point about 1½ miles from the mouth of San Jacinto River, and distant about 28½ miles from Galveston. The general width near its mouth is 250 feet, and the ruling depth over the bar at its mouth was 3 feet at mean low tide, while inside a depth of 7 feet existed.

The approved project for this improvement consists in deepening the channel over the bar by dredging, so as to afford a depth of 5 feet at mean low tide, the width of the cut to be about 100 feet, the cut to be protected by brush and stone walls or jetties, rising to a height of about

2½ feet above mean low tide. The total length of these jetties, which were to extend across the bar to a depth of 5 feet in Galveston Bay, was about 5,000 feet. The estimated cost of the work, as revised in 1893, was $38,650.

At the close of the last fiscal year the condition of the work was as follows:

The north jetty was completed for a distance of 1,413 feet, and the south jetty for a distance of 2,888 feet; 1,371 feet of this latter requires raising about 1½ feet in order to complete it.

Operations during the present fiscal year were confined to dredging a channel across the bar between the jetties.

Proposals for dredging were invited through public advertisement, dated October 6, 1893, but no bids were received at the time of opening, November 6, 1893. It was then recommended that the work be done by hired labor and purchase of material in open market. This recommendation having been approved, a dredge, with full complement of men and tools, was hired from J. H. Hawley, of Galveston, Tex., and dredging was commenced on December 18, 1893. Operations were continued until April 10, 1894, when the dredging was completed.

The work during the season was confined to widening the channel over the bar and extending it 430 feet bayward; 21,000 cubic yards of material was removed by the aid of a suction dredge, dynamite, and scour due to tidal action.

The channel across the bar is now 2,830 feet long, 90 feet wide, and 5 feet deep at mean low tide.

The details of the season's operations are shown in the report of Mr. R. B. Talfor, assistant engineer, which is forwarded herewith.

Amount expended to June 30, 1893	$24,478.45
Amount expended during fiscal year	7,671.55
Total expended to June 30, 1894	32,150.00

Abstract of appropriations made by Congress for improving Cedar Bayou, Texas.

By act of—	
September 19, 1890	$18,150
July 13, 1892	14,000
Total	32,150

The sum of $6,500 can be profitably expended during the fiscal year ending June 30, 1896, in extending the jetties about 1,000 feet, which will complete the project.

The work is located in the collection district of Galveston. The nearest lighthouse is at Redfish Bar.

Money statement.

July 1, 1893, balance unexpended	$7,671.55
June 30, 1894, amount expended during fiscal year	7,671.55
Amount (estimated) required for completion of existing project	6,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	6,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1894.

MAJOR: I have the honor to submit the following report on the Cedar Bayou Bar improvement for the fiscal year ending June 30, 1894:

Work was begun December 18, 1893, with an available amount of $7,500. As no bids were received, presumably on account of the smallness of the appropriation, and the well-known hard nature of a large part of the material to be dredged, it was decided to try an experiment, using dynamite (40 per cent) and a suction dredge or sand pump, the pump to excavate the soft places and the dynamite to loosen and disintegrate the hard material, leaving it in such a condition that it could be carried seaward by the action of the current produced by the jetties, pumped over the south jetty, or into the angle formed by the north jetty and Ashes Point.

The suction dredge hired for this experiment had been used in filling in a portion of the wharf front at Galveston and was described as follows:

"The dredge *Jakie* being 90 feet in length and 26 feet beam drawing a little less than 2½ feet of water. * * *

"Machinery, one 55-horse-power engine and boiler. One 10-inch Edward's cataract pump, Wheeler 100-horse-power surface condenser and all necessary piping, hose, anchors, etc., with a full complement of experienced men to handle the same."

On the arrival of the dredge it was found she was unsuited for the work to be done, chiefly on account of the method of supporting the discharge pipe used in carrying the water and small amount of material carried in suspension to the place of deposit, it having been the custom to support the discharge pipe on wooden trestles 20 feet apart, and as the dredge moved forward to extend the pipe by placing additional joints next to the dredge and additional trestle for its support, thereby causing a great loss of time and a considerable expense in labor and material for these trestles which would afterwards have to be removed at an extra cost, the material being so tenacious it was exceedingly difficult to handle the few that were used at the commencement of operations. This method was of necessity abandoned, and the discharge pipe was placed on a small barge about 20 feet long and a still smaller flat at the outer end on which it was supported and raised to a proper height to conform to the discharge end of the dredge, the pipe being encased in 2-inch planks placed at the side with 1 by 3-inch strips at top and bottom. This plan proved to be much more successful, as no time was lost except for the necessary moving of the dredge, the whole plant being practically one body. Other changes were made, notably the enlargement of the suction below the foot valve, which proved a very material benefit, and the substitution of a rotary for small centrifugal pump used to operate the jet. This, however, did not prove as much of a success as was expected, the pump being old and worn, badly erected, and the supply of steam insufficient. Taking into consideration the many difficulties encountered and the unusual loss of time caused by bad weather, which on several occasions damaged the plant materially, I will say, that I conceive the experiment a success, more especially as the bottom and sides of the cut are now in such a condition (particularly where the channel is narrowest and shoalest) that the tidal current and freshets will easily erode them, having been penetrated by the suction and disintegrated by the charges of dynamite. It is therefore confidently expected that the channel will continue to improve.

The insufficient height of the south jetty permits a large amount of water to escape over it at high tides and freshets, thereby reducing the scouring force of the current. In my opinion it would be much more effective if it were raised from 1½ to 2 feet.

DREDGING.

The work done from December 18, 1893, to April 10, 1894, was confined mostly to the widening of the channel over the bar, and extending it 430 feet bayward, making the total length of the channel dredged 2,830 feet with a least depth of 5 feet at mean low tide and least width of 90 feet; 21,000 cubic yards of material was removed by the aid of the suction dredge, dynamite, and the scour due to tidal action; the excavation being made on the north side of the old cut.

No difficulty was found in using the dredge from cross section 0 to 5 and from section 11+100 to section 14, as the bottom was of mud and sand mixed. The intervening space between sections 5 and 11 being of very stiff clay, it was over this area that the dynamite was used.

The total amount expended on the work being $7,500, including the hire of dredge with its crew, dynamite, and inspection, put the cost at 36 cents per cubic yard of material removed.

The amount of material removed was determined by cross sections taken before the commencement of the work and after its completion.

The cost was increased owing to the time lost by bad weather, repairing of machinery, etc., which amounted to two hundred and eighteen hours, or 27.27 working days of eight hours each, which is 40 per cent of the total time engaged.

DYNAMITE.

Nine hundred and fifty pounds of 40 per cent dynamite was used on the north side of the cut between cross sections 5 and 11+70, covering a distance of 1,270 feet in length, the charges ranging from one-half to 4 pounds, each fastened to canes about 10 feet long. It was found that in the soft strata of clay, blasts of one-half to 1½ pounds each gave better results than heavier charges. In the stiff and heavy clay a battery of 5 charges, containing 14 pounds, 4 pounds near the edge of the channel (2 pounds being placed at corners 12 feet apart), and 6 pounds placed from 8 to 10 feet back toward the shore (3 pounds being placed at corners 12 feet apart), with a 4-pound charge in the center, was found to disintegrate the material from 3 to 6 feet beyond the area blasted and the material raised from 1 to 2½ feet above the original bottom, leaving it in such a condition that it could be handled by the suction dredge. The amount of material removed is shown by cross sections accompanying this report. There is no doubt that a considerable amount of this was carried off by the current. The holes made for the charges had a penetration of from 3 to 5 feet in the clay bottom, the area blasted having a depth of from 1 to 4 feet of water. The total number of charges placed was 513, of which 20 missed fire, the cost of which is as follows:

950 pounds of 40 per cent dynamite, at $20 per 100	$190.00
3,500 feet of double water-proof fuse, at 75 cents per 100	26.25
7 boxes of exploders, at 75 cents per box	5.25
Total	221.50

It was intended before the work stopped to re-cross-section the north jetty to show the amount of fill caused by the deposit from the dredging operations, but the weather for the fifteen days previous to April 10 was too rough to make accurate soundings, and the time to which the dredge was hired (April 10) having expired, only the south jetty with the dredged channel was cross-sectioned, and the shore line from Ashes Point to the mouth of the bayou, and the point at the inner end of south jetty was run. Very little of the bank southeast of Ashes Point has been eroded since the south jetty was built. From inner end of the jetty the shore line has built out and over the jetty for about 130 feet. Very little of the mattress work is now exposed, it being covered with the material dredged from the channel. A like condition is noted at the north jetty, where the accretions extend from the shore end of the jetty out for about 400 feet, so that it is now dry at mean low tide where previously there was 2 feet of water. In conclusion would state that I am indebted to Capt. Abm. Cross, overseer, for the improvements made in the methods of carrying the discharge pipe and suction bell, thereby facilitating the progress of the work.

Respectfully submitted,

R. B. TALFOR,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF CEDAR BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Vessels using the bayou, 22 (13 sailing vessels, 7 barges, and 2 steam tugs); draft, 3 to 5 feet; tonnage, 4 to 135 tons; trips made 912; total tonnage, 22,884.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Brick	24,000	$57,600	$9,600
Cotton	50	7,400	100
General merchandise	7,960	75,840	7,960
Total	32,010	140,840	17,560

Increase since last year, 11,040 tons.

Comparative statement of commercial statistics of Cedar Bayou, Texas, for fiscal years 1891 to 1894.

Year.	Vessels using bayou.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1891	18	60	3.5	96	.....	.....
1892	16	65	4.5	96	1,080	26,940
1893	15	80	4.5	135	996	20,777
1894	22	110	5.0	135	912	22,884

Transported.

Year.	Brick.	Cotton.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*		
1891	17,500	50	1,709	19,250	$108,250	$18,612
1892	15,000	50	4,992	20,042	128,250	18,113
1893	15,920	75	4,975	20,970	139,020	16,286
1894	24,000	50	7,960	32,010	140,840	17,560

U 6.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

Buffalo Bayou is a tide-water stream, emptying into San Jacinto River at Lynchburg, about 25 miles below Houston and about 8 miles above the junction of the San Jacinto with Galveston Bay. White Oak and Simms bayous are tributaries, the former entering at Houston and the latter at a point about 11 miles below.

A survey of the bayou, with a view to its improvement, was made in 1871, and a subsequent examination between White Oak and Simms bayous was made in 1880. The estimated cost of obtaining a channel 100 feet wide and 12 feet deep in this stream, as stated in the report on the examination, was $385,299.75.

The object of the improvement is to secure for Buffalo Bayou a channel having the same dimensions (100 feet wide and 12 feet deep) as the one contemplated for Galveston Bay, the aim being to admit seagoing ships to Houston. These dimensions of channel exist naturally in Buffalo Bayou below Simms Bayou and in the San Jacinto River, though it is reported that a small bar exists in San Jacinto River near Morgan Canal.

Morgan Canal is the name given to a channel excavated by the Buffalo Bayou Ship Channel Company through Morgan Point, a peninsula at the mouth of San Jacinto River. In Galveston Bay, in prolongation of the canal, is Morgan Cut, also executed by the same company, connecting it with the ship channel dredged in the bay by the United States. The canal and cut now belong to the United States.

It is between White Oak and Simms bayous that improvement of Buffalo Bayou is almost entirely needed. The banks here are high and generally stable, though occasionally subject to landslides. The surface width is generally greater than 100 feet, though there are some exceptions to this rule. The depth in the middle of the channel is usually 9 feet or more at ordinary tide, but there are occasional shoals upon which as little as 5 or 6 feet is found, and during northers the water surface is sometimes lowered several feet. At some points navi-

gation is obstructed by the sharpness of the bends. It is endangered also by sunken logs and stumps in the bed of the stream and by overhanging trees upon the banks.

The commerce of the bayou is important. It is mostly carried on by means of barges towed by tugs. The draft of the latter is 7 feet or less, that of the former, when full loaded, about 5 feet.

Even if but partial improvement of the channel be made with the sums appropriated, so as to secure 9 or 10 feet of water at mean low tide, the resulting benefit will be not only immediate but great, and this benefit will be increased by easement of bends and removal of snags, trees, etc. When a 12-foot depth is maintained throughout from Bolivar Channel to Morgan Cut and Canal, and through the latter to San Jacinto River, the depth of Buffalo Bayou can be correspondingly increased as appropriations are made.

A new supply of sunken logs is found annually in Buffalo Bayou, and considerable shoaling from surface wash also occurs annually.

The first appropriation for the improvement of this stream was made in 1881, and subsequent appropriations have been added from time to time. The money has been applied to dredging, easing of bends, and in removal of stumps, logs, and overhanging trees. This work has been of great benefit to the navigation of the stream, enabling boats drawing 8 feet of water to reach Houston without difficulty.

Work during the fiscal year consisted in a continuation and completion of contract entered into with Lockwood Megget, of Houston, Tex., during the previous fiscal year, for dredging and removal of obstructions. The work was completed on September 3, 1893, and the amount accomplished from July 1 to September 3, 1893, was as follows:

Twenty-seven thousand nine hundred and eighty cubic yards of material dredged, and 79 sunken logs and 65 stumps removed. A drain was also built at Harrisburg to prevent dirt being washed into the bayou during heavy rain storms.

The work accomplished under appropriation made by act of July 13, 1892, has resulted in a 10-foot channel for navigation from Houston to Harrisburg, a distance of 8 miles.

The details of the season's operations are shown in the accompanying report of Mr. R. B. Talfor, assistant engineer, to which attention is invited.

The trade of the bayou is practically carried on by the Houston Direct Navigation Company with tugs and barges, but many small vessels visit it. To ascertain the extent of the trade, a special agent was employed to keep a daily record of the commerce and tonnage of the bayou. Large shipments of cotton are made from Houston to Galveston by water, to be loaded on seagoing vessels at the latter place. The number of bales shipped down the bayou during the present fiscal year was 275,378.

Amount expended to include June 30, 1893	$173,217.98
Amount expended during present fiscal year	19,921.51
Total amount expended to June 30, 1894	193,139.49

It is estimated that the sum of $50,000 can be profitably expended during the fiscal year ending June 30, 1896, in continuing the improvement by again going over the ground, more or less, where dredging has been done; in widening the waterway where the surface width is less than 100 feet and where the cost of widening is not excessive, and where the banks will bear such widening without danger of sliding; in deepening the channel where its depth is less than 10 feet; in easing the bends and in removal of logs, stumps, etc.

Abstract of appropriations made by Congress for improving Buffalo Bayou, Texas.

By act of—	
March 3, 1881	$25,000
August 2, 1882	50,000
July 5, 1884	25,000
August 5, 1886	18,750
August 11, 1888	25,000
September 19, 1890	25,000
July 13, 1892	25,000
Total	193,750

The work is located in the collection district of Galveston. The nearest lighthouses are those in Galveston Bay.

Money statement.

July 1, 1893, balance unexpended	$20,532.02
June 30, 1894, amount expended during fiscal year	19,921.51
July 1, 1894, balance unexpended	610.51
Amount (estimated) required for completion of existing project	191,549.75
Amount that can be profitably expended in fiscal year ending June 30, 1896	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1894.

MAJOR: I have the honor to submit the following report of work done on the Buffalo Bayou improvement for the fiscal year ending June 30, 1894.

This work comprised the continuance and completion of a contract entered into with L. Megget during the preceding fiscal year for dredging and removing sunken logs and stumps from the bed of the bayou, and overhanging trees from the banks, and was finished September 3, 1893.

From July 1 to September 3 the following amount of work was done:

Dredged 27,980 cubic yards material, at 40 cents per yard	$11,192.00
Removed 79 sunken logs, containing 1,293 cubic feet, at 7½ cents per foot.	96.98
Removed 65 stumps, requiring forty hours and twenty-five minutes' time of plant, at $14.85 per hour	662.67
1 wooden drain placed at Harrisburg	157.05
Total	12,108.70

The drain above mentioned was placed in a gully at Harrisburg, through which a large amount of material was carried into the bayou during the prevalence of heavy rains, causing considerable shoaling at that point. Since the drain has been placed, there has been no appreciable shoaling.

The work of improving the navigability of the bayou can not be considered by any means permanent, as nearly, if not fully as much material is yearly washed into it from the banks, gullies, and natural tributaries, together with sewers, artificial drains, etc., as can be removed with the small appropriation allowed for the work to make it in any way permanent. I believe the banks should be revetted and the water emptying into it should be carried through pipes, and when the quantities are large, through covered drains with basins of as large capacity as practicable back of them, so as to allow at least a portion of the material carried in suspension to be deposited instead of passing into the stream.

The commerce is, as you are aware, very large, and is increasing. The tendency of the stream is to fill, and the obstruction from overhanging trees to become greater, so much so that in my opinion the vessels now navigating it would, in a very few years, without the maintenance received from the annual appropriation, be unable to come up any farther than Constitution Bend. I use the word maintenance, because I do not believe the appropriations allowed for the work do more than maintain its navigability instead of improving it. I would also respectfully call your

attention to the condition of the turning point at the mouth of White Oak Bayou which is continually becoming shoaler, chiefly from the deposit from the drainage of the streets of Houston, and from the piece of land used as a wharf between the foot of Fannin and Main streets. This ought to be properly bulkheaded by the city of Houston.

The work done during the months of July and August embraced the area between the San Antonio and Aransas Pass Railway bridge and the city of Houston. The shoal near the drain at Harrisburg was removed by the contractors at their own expense, they having a line of barges engaged in the bayou trade, and the appropriation being exhausted.

Very respectfully,

R. B. TALFOR,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Vessels using the bayou, 100 (10 steam vessels, 28 barges, and 62 sailing vessels); length, 20 to 162 feet; draft, 2 to 6.5 feet; tonnage, 2 to 358 tons; trips made during the year, 3,000; total tonnage, 307,819 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton and products	76,766	$11,868,052	$137,367
Wood and coal	11,419	48,953	7,539
Lumber and shingles	841	9,421	1,478
General merchandise	19,039	336,241	23,611
Total	108,065	12,262,667	169,995

Increase since last year, 1,419 tons.

Comparative statement of commercial statistics of Buffalo Bayou, Texas, for fiscal years 1888 to 1894.

Year.	Vessels using bayou.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	89	173	8	254	920	.....
1889	64	173	7	254	735	.....
1890	68	173	7	254	617	.....
1891	68	162	6	358	2,274	295,869
1892	114	162	6.5	358	3,345	398,452
1893	112	162	8	413	2,587	303,764
1894	100	162	6.5	358	3,000	307,819

Transported.

Year.	Cotton and products.	Wood and coal.	Lumber and shingles.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	36,651	4,320	2,765	6,105	49,841	$5,132,323	$94,960
1889	53,855	3,456	1,221	2,018	60,550	7,617,380	98,794
1890	86,051	2,970	512	6,701	96,234	13,880,766	154,715
1891	94,017	9,810	622	3,639	108,088	16,243,395	156,906
1892	105,939	15,595	1,538	9,112	132,179	13,790,650	206,719
1893	80,596	8,343	1,001	16,706	106,646	12,836,894	175,759
1894	76,766	11,419	841	19,039	108,065	12,262,667	169,995

U 7.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

The project for the improvement of this harbor, adopted in 1881, contemplated the construction of two jetties extending out into the Gulf of Mexico, the object being to fix the channel over the bar at the entrance to the harbor and to deepen it. These two jetties were to be built about 1,500 feet apart, and one, the south or Brazos Island Jetty, to be 3,630 feet long, and the other, the north or Padre Island Jetty, to be 2,940 feet long. Work was suspended on this improvement in October, 1884, the Brazos Island Jetty having been completed, and the subject of the improvement referred to The Board of Engineers for report. A new survey was called for, which was made in 1887, and reported on September 29, 1887. The report showed that the south or Brazos Island Jetty, completed in 1884, had practically disappeared. The cost of an improvement, to consist of two parallel jetties placed about 1,100 feet apart, was estimated at $1,130,000, and it was stated that at least $600,000 should be available before work was commenced. Adding previous expenditures of $188,590.23 to this estimate, makes the revised cost of the improvement $1,318,590.23.

Nothing has been done on this work since the survey made in 1887, the amount of money available having been too small to warrant commencing it.

A special agent was employed during the year to keep a record of all incoming and outgoing trade. Commercial statistics compiled from his record are herewith.

The conclusion that not less than $600,000 should be available before undertaking further work is here concurred in, though it is not asserted that the amount of commerce to be benefited justifies such an expenditure at this time. There remains, in round numbers, $543,000 as the sum that should be appropriated for the fiscal year ending June 30, 1896, in case Congress orders the improvement continued.

Original estimated cost of the work as revised in 1888	$1,318,590.23
Aggregate amount appropriated to June 30, 1894	247,500.00
Amount expended to July 1, 1893	189,858.59
Amount expended during fiscal year	75.41
Total expended to July 1, 1894	189,934.00

In addition, $6,000 was appropriated in 1878, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest lighthouse is the Brazos Santiago Light on Padre Island.

Abstract of appropriations made by Congress for improving harbor at Brazos Santiago, Tex.

By act of—	
June 14, 1880	$25,000
March 3, 1881	75,000
August 2, 1882	60,000
July 5, 1884	25,000
August 5, 1886	37,500
August 11, 1888	25,000
Total	247,500

Money statement.

July 1, 1893, balance unexpended	$57,626.41
June 30, 1894, amount expended during fiscal year	75.41
July 1, 1894, balance unexpended	57,551.00
Amount (estimated) required for completion of existing project	1,071,090.23
Amount that can be profitably expended in fiscal year ending June 30, 1896	543,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEX., FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Vessels using the harbor, 18 (5 steamers and 13 sailing vessels); length on deck, 36 to 220 feet; draft, 3 feet to 9 feet 4 inches; tonnage, 8 to 718 tons; trips made during the year, 144; total tonnage, 51,127 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Wool and hides	2,612	$130,600	$21,182
Lumber	2,521	30,750	9,329
General merchandise	8,826	450,018	99,158
Total	13,959	611,368	129,660

Decrease since last year, 3,464 tons.

Comparative statement of commercial statistics of Brazos Santiago Harbor, Texas, for fiscal years 1888 to 1894.

Year.	Vessels using harbor.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	12	241	10	678	126	44,741
1889	14	241	10	678	158	46,319
1890	20	219	9	717	170	40,641
1891	20	220	10.5	717	120	44,536
1892	15	220	9.4	717	127	48,724
1893	26	220	9.4	717	158	44,927
1894	18	220	9.4	718	144	51,127

Transported.

Year.	Cotton.	Wool and hides.	Lumber.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888		2,925	2,324	9,867	15,166	$737,432	$83,541
1889	130	3,080	3,188	10,885	17,283	820,315	78,140
1890	80	4,153	2,938	14,844	22,015	1,069,189	129,132
1891		3,218	2,434	15,992	21,644	1,061,082	160,215
1892		3,092	1,865	12,538	17,495	846,946	165,852
1893		2,469	2,243	12,711	17,423	811,289	159,723
1894		2,612	2,521	8,826	13,959	611,368	129,660

APPENDIX V.

IMPROVEMENT OF CERTAIN RIVERS AND WATERWAYS IN LOUISIANA, TEXAS, ARKANSAS, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO MISSISSIPPI RIVER; WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TBIBUTARIES.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Red River above Fulton, Ark.
3. Ouachita and Black rivers, Arkansas and Louisiana.
4. Bayous D'Arbonne and Corney, Louisiana.
5. Bayou Bartholomew, Louisiana and Arkansas.
6. Bœuf River, Louisiana.
7. Tensas River and Bayou Maçon, Louisiana.
8. Big Black River, Mississippi.
9. Yazoo River, Mississippi.
10. Mouth of Yazoo River, Mississippi.
11. Tchula Lake, Mississippi.
12. Tallahatchee River, Mississippi.
13. Steele and Washington bayous, Mississippi.
14. Big Sunflower River, Mississippi.
15. Big Hatchee River, Tennessee.
16. Forked Deer River, Tennessee.
17. Water gauges on Mississippi River and its principal tributaries.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 2, 1894.

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

V 1.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

The Red River of the South has its source in the *Llano Estacado*, in the panhandle of northwestern Texas, and flows in a general easterly direction, forming the boundary between Oklahoma and Indian Territories and Arkansas on the north and Texas on the south. It enters

the State of Arkansas about 10 miles north of Texarkana, and from Fulton, Ark., to Shreveport, La., its course is changed to a general southerly direction. Below the latter place its course again changes to a general southeasterly direction, and crossing the State of Louisiana it enters the Mississippi River at Red River Landing. The river is about 1,200 miles long. The part included in the project under the title of improving Red River, Louisiana and Arkansas, extends from Fulton, Ark., to the head of Atchafalaya River, Louisiana, a distance of 508.6 miles.

The importance of this great waterway was recognized by Congress as early as 1828, and appropriations for the removal of raft, amounting to more than half a million dollars, were made at intervals between 1828 and 1852. Between 1841 and 1852 no appropriation was made for continuing operations, and a longer period elapsed between 1852 and 1872, during which the results of former work were lost. The lower end of the great raft once was at Natchitoches, if not, as many suppose, still further downstream, and it extended up the river for more than 100 miles; not in an entire jam, but at intervals, with stretches of clear river between. In 1854 its head had advanced to a point about 50 miles above Shreveport, its length was 13 miles, and it was reported to be forming at the rate of 1½ to 2 miles a year. Between 1855 and 1860 the heavy rates of freight and insurance and disastrous effects of backwater from the raft became so burdensome to the planters that a corporation was chartered under the State laws for the removal of the raft; the assent of Congress was given to the method of improvement by joint resolution of February 21, 1861, and the company authorized to levy tolls for a period of thirty years. (Stat. at Large, vol. 12, p. 250.) The company was organized and preparations were made to begin work in the spring of 1861, but the war of the rebellion prevented anything being done.

The appropriations for the early work, from 1828 to 1852, were as follows:

Date of act.	General object of appropriation.	Amount.
May 23, 1828	Improving navigation of Red River through or around the raft in Louisiana and Arkansas	$25,000.00
Mar. 2, 1831	Arrearage due Maj. Burch for survey of raft of Red River, Louisiana	187.50
July 3, 1832	Improving navigation of Red River, Louisiana and Arkansas, being balance of appropriation of 1828 carried to surplus fund, and the further sum of $20,000	22,628.00
June 28, 1834	Improving navigation of Red River	50,000.00
Mar. 3, 1835	Completing removal of obstructions to navigation of Red River	50,000.00
July 2, 1836	Continuing the removal of obstructions in Red River	40,800.00
	Constructing a boat to prevent a new accumulation of obstructions in Red River within the old limits of the great raft, $15,000, and to work and support same, $15,000	30,000.00
Mar. 3, 1837	Continuing the removal of obstructions in Red River	65,000.00
Apr. 20, 1838	The complete removal of the great raft in Red River	70,000.00
Mar. 3, 1841	Removing the raft of Red River	75,000.00
Mar. 2, 1847	Deficiency of appropriation by act of Apr. 20, 1838, being amount advanced by Daniel T. Witlee and others through the branch of the Real Estate Bank of Washington, Ark., to Henry M. Shreve, Government agent, for removal of great raft and expended by him for that purpose	7,150.00
Aug. 30, 1852	Removing the raft of Red River	100,000.00
	Aggregate of appropriations, 1828–1852	535,765.50
	Amount expended	532,219.90
	Amount carried to surplus fund	3,545.60

An examination and survey of Red River from its mouth to the head of the raft were ordered by river and harbor act approved March 3, 1871, the reports of which are contained in Reports of the Chief of *Engineers for 1872*, pp. 568–573, and 1873, pp. 635–676, under which the

present improvement commenced in 1872. The original project contemplated removing the raft above Shreveport, La., and closing Tones Bayou Outlet, on the right bank, 19 miles below Shreveport, the gradual enlargement of which diverted a large quantity of water from and seriously affected navigation of the main river below. Subsequently this project was enlarged to include the removal of jams, snags, wrecks, leaning timber, etc.; opening and enlarging the channel through the falls at Alexandria, La.; deepening the channel at shoal places, and closing outlets and constructing and repairing levees to confine the river to the adopted channel, in order to improve and keep navigation open from Fulton, Ark., to the head of the Atchafalaya; also to protect the banks at Alexandria and Shreveport from erosion by the current of the river, and to make a thorough and comprehensive survey from Fulton to the Atchafalaya with a view to the permanent improvement of the river.

The appropriations for the improvement, commenced in 1872, have been as follows:

Date of act.	General object of appropriation.	Amount.
June 10, 1872	Improvement of Tones Bayou, Louisiana	$20,000
	Removing the raft in Red River, Louisiana	150,000
Mar. 3, 1873	....do	80,000
June 23, 1874	....do	50,000
Mar. 3, 1875	....do	20,000
Aug. 14, 1876	Removing the raft in Red River and closing Tones Bayou	35,000
Apr. 10, 1869	Allotment made Aug. 27, 1877, for closing Tones Bayou	4,500
Feb. 7, 1878	Opening navigation of Red River above Shreveport, La., and keeping same open and free from rafts, and for the purpose of preserving vessels of United States employed in that work	6,000
June 18, 1878	Removing raft in Red River and closing Tones Bayou	24,000
	Removing snags and other obstructions from Red River	25,000
Mar. 3, 1879	Removing raft in Red River and closing Tones Bayou	15,000
	Removing obstructions from Red River	22,500
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
June 14, 1880	Removing raft in Red River and closing Tones Bayou	25,000
	Removing obstructions from Red River, Louisiana, including construction of snag boat	60,000
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
Mar. 3, 1881	Removing raft in Red River and closing Tones Bayou	10,000
	Removing obstructions from Red River, Louisiana	10,000
Aug. 2, 1882	Continuing improvement from the Atchafalaya to Fulton, Ark., including Bayou Pierre, Tones Bayou, and to relieve the town of Alexandria from encroachments of the river	75,000
July 5, 1884	Continuing improvement from the Atchafalaya to Fulton, Ark.; not exceeding $15,000 for revetment to protect the harbor at Alexandria from damage by the current of river; not exceeding $5,000 to close the outlet known as Sale and Murphy Canal; the remainder to be applied to improvement of the main channel of the river	75,000
Aug. 5, 1886	Continuing improvement from Fulton, Ark., to the Atchafalaya River, Louisiana, including completing the work at Alexandria; $25,000, or so much thereof as necessary, to be used in making a thorough survey of the river from Fulton to the Atchafalaya, and in completing survey of Bayou Pierre, Louisiana	75,000
Aug. 11, 1888	Continuing improvement from Fulton, Ark., to the Atchafalaya River, including completing the work at Alexandria: $5,000, or so much thereof as necessary, to be used upon Cypress Bayou, and the lakes between Shreveport, La., and Jefferson, Tex., and $5,000, or so much thereof as necessary, upon Bayou Dorcheat	65,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	35,000
Sept. 19, 1890	Continuing improvement from Fulton, Ark., to the Atchafalaya River; $15,000, to be used in the work at Alexandria; $20,000 to be used in deepening and widening that portion known as Little River, from the Scopini Cut-off to Knox Point, and $5,000 in closing the Sale and Murphy outlet	100,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	28,000
July 13, 1892	Continuing improvement from Fulton, Ark., to the Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey, including the work at Alexandria, the widening of that portion known as Little River, the necessary work at the harbor at Shreveport, the closing of outlets on the west bank of the river above Shreveport, and the removal of the tow-head just above Rush Point, Caddo Parish (of which $5,000 may be used, in the discretion of the Secretary of War, for work in Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex.)	145,000
	Aggregate of appropriations, 1872 to 1894	1,175,000

The amount expended under the project of 1872, to June 30, 1893, wa $1,079,604.28 (including outstanding liabilities of $1,676.32), resultin in great benefit to navigation. In 1872 the great raft had grown to length of 32 miles, an increase of 19 miles since 1854, extending fro Carolina Bluffs, 33 miles above Shreveport, to within 4 miles of th Arkansas and Louisiana line, and, judging from the photographs take before and during operations, one would say that it had been easier t cut through rock than to make a navigable river through the mass tangle that grew higher and larger with every flood. The river abo the raft was reached only by devious routes, through lakes and ove flowed lands on either side, and canals dug by private parties, wh exacted heavy tolls, and even these routes were not navigable exce at stages considerably above low water. A channel was opened throu the raft in 1873, and the intermittent work of the snag boats sin aided by the action of the current and by the incomplete system levees built by the United States, the State of Louisiana, and local d tricts, have secured greater width and depth throughout the ent reach, with a channel-way constantly scouring, until to-day there flows the course marked out for it a broad and deep river, safe at all but t very lowest stages, except for an occasional snag that drifts from abo or a log that rises from the bottom as it scours. Moderate estima placed the annual saving to the planting interest from the removal the raft at $150,000, besides relieving to a great extent not less th 25,000 acres of fertile lands from overflow. (See Report Chief of En neers, 1873, p. 665.) A comparison of levels of 1893 with those of t survey of 1872 showed that the low-water line had fallen more than feet at the head of the raft, diminishing to about 3 feet at Shreveport and that a similar reduction had been going on in the river below.

Several ineffectual attempts were made to close Tones Bayou outl on the right bank, 19 miles below Shreveport, but no work has be done at that point since 1882, when the dam under construction w destroyed. The outlet has been filling up gradually with drift, a this in connection with the work of the snag boats in the old r region above and below, has caused what is known as the Little Riv below the mouth of the bayou, to widen and scour. Discharge obser tions taken twenty-one years ago gave about one-quarter to Lit River, the rest escaping through Tones Bayou or over the banks in Bayou Pierre. Now fully two-thirds of the flood is carried down Lit River, and as the stretch was leveed along both sides in 1893, there no doubt that Little River will soon be able to carry the whole.

The rock excavation and dam at the Falls of Alexandria were co pleted in 1885, increasing the period of navigation about two month and as a general thing permitting boats to pass the falls the ye round. The passage, however, was found to be somewhat difficult a low stages, and in the low-water season of 1892–'93 dredging operation were resumed, improving the difficult piece of navigation at the Uppe Falls greatly, and leaving only a small amount of work to make it saf A crib dam and training wall were built in 1884–'85, to protect th bank in front of Alexandria from erosion by the current of the rive and in 1892–'93 this work was strengthened and the caving bank belo the influence of the dam revetted with the stone excavated from th channel at the Upper Falls.

The removal of snags, logs, and wrecks from the channel and clea ing the banks for the general improvement of the river from Fulton the Atchafalaya were not begun until 1878, all former appropriatio having been for the removal of the raft and closing Tones Bayou; b

since 1885 operations have consisted chiefly of that class of work, and by the persistent efforts of the snag boats the river has been kept open, the raft prevented from forming again, the dangers of navigation reduced to a minimum, and steamboats enabled to make regular trips at the lowest stages of water; a condition barely hoped for when the improvement was undertaken. This work should be continued for many years, as sunken logs and stumps are scouring loose continually and are a source of great danger to low-water navigation; others, thoroughly water-logged, form bars impassable at low stages, and the banks of the upper river for hundreds of miles are covered with a heavy growth of timber, which is caving and sliding into the river continually, and during high stages the amount of drift is enormous. In the raft region above Shreveport jams form in a few hours often acres in extent, and require prompt removal before the water falls. The caving banks leave dangerous shore snags projecting far out into the stream, which should be cut after every rise and fall.

The work of closing outlets and building levees to confine the river to the adopted channel was begun in 1891, when the Sale and Murphy Outlet, near the Arkansas and Louisiana line, was closed by a heavy earthen dam, which caused the channel through the old raft region below to scour rapidly. In the fiscal year 1893 a system of levees was commenced by cooperation of the United States with the State of Louisiana and local levee boards, extending from the hills just above the Arkansas State line downstream. During that year levee work was undertaken to the amount of 3,246,088 cubic yards, aggregating 75 miles in length and costing more than $550,000. Only about one-tenth of this work was built by the United States and the proportion of its cost borne was less than 9 per cent.

The survey of the river was carried from Fulton, Ark., to the Atchafalaya River, and checked by a line of precise levels from Delta to Shreveport, La., connecting it with the Mississippi and continuing down Red River from Shreveport to its mouth. This survey will not suffer by comparison in cost, grade, or completeness with any work of its kind, and as it had been decided to postpone or omit secondary triangulation from the Atchafalaya back to Fulton, all that remained to be done at the close of last fiscal year was the making of transvalley sections and borings, the determination of high and low water limits and discharge, reconnoissances to note changes since the work commenced, and the completion and publication of the maps. The value of the survey was tested practically in 1893 by the State engineers of Louisiana in locating new levees from blue prints of the maps, on which the preliminary lines were marked and profiles constructed from the elevations noted on them and the grade fixed by the high-water line of 1892 furnished by this office. The State engineers reported that these maps were practical working drawings, and that they found hardly any changes necessary in laying out the lines in the field. Thus much time and money were saved, and they were enabled to put so large an amount of work under contract.

As stated heretofore, whatever plan may be adopted for the permanent improvement of Red River, or even if the work of giving an assured reasonable navigation to Shreveport and beyond be delayed for a time, there are certain general principles to be followed, if only to save till that time comes what has been gained, or to prevent the river closing. These principles are stated in natural sequence, as follows:

1. The systematic clearing of the banks for some distance back, far

beyond the limits of this district. It is cheaper to remove the source of drift than to dispose of the drift itself, and the benefit to navigation is immediate.

2. An efficient snag-boat service for general work, patrolling the river, preventing jams, removing snags and logs from the channel and banks, and dredging towheads and obstinate shoals. Here, again, the benefit is immediate. A permanent appropriation of not less than $25,000 a year is needed for this purpose.

3. Extending the scope of the survey to embrace the whole valley. This is necessary to the proper study of this river and tributaries, and to furnish all the information required to decide upon a system of improvement and to locate its elements.

4. Construction of a substantial system of levees to restrain the greatest floods, either alone or in conjunction with the riparian States.

5. Closing gradually every outlet through which the main stream is depleted at various stages above low water.

6. Fixing caving banks to confine the main stream to the channel selected for it. Ordinarily fixing caving banks should precede levee building and closing outlets, but as the banks are reasonably stable for a considerable part of Red River, and as the object is to get improved navigation without unnecessary delay, revetment is placed after them.

7. To exercise a watchful care from first to last to prevent injury to the regimen of the river by cut-offs or outlets, and to keep the building of bridges within reasonable bounds.

During the fiscal year ending June 30, 1894, operations were continued as follows:

GENERAL IMPROVEMENT.

July 6, 1893, the United States snag boat *C. W. Howell*, M. B. Lydon, master, left Shreveport for Alexandria, La., reached the latter place July 8, and from that date to July 12 was employed in towing the hand-propelled snag boat *Harry Breck* to Shreveport, to have it ready for work in the river above. July 13 the *Howell* commenced snagging operations, and between that date and July 27 they were carried upstream to the Head of Raft, 65 miles above Shreveport. This stretch of river was worked over thoroughly, and all obstructions that could be found were removed. The sweep-chain was dragged over the entire distance, and a large number of logs were dislodged from the bottom and destroyed. The wreck of the steamer *Friendly*, sunk October 8, 1892, at Douglas Place, La., was removed entirely; of the wreck of the steamer *Phil. E. Chappell*, sunk in 1888 at White Hall, the wheel, shaft, pitmen, cylinder timbers, and all other parts that could be reached, were removed; and the cylinders and cylinder timbers of the wreck of the steamer *Monterey*, sunk in 1863 near Moultrie, La., were removed. July 28 to August 3 the *Howell* remained at Shreveport undergoing minor repairs, and the crew assisting in the construction of a flatboat for use of the survey party. The latter date it left for Alexandria, to work upstream over the stretch of river between those places, reached Alexandria Sunday, August 6, and commenced working back the following day. On account of complaints, by steamboat men, of a large number of snags in the channel, operations were carried upstream as rapidly as possible, and only the worst obstructions removed, with a view to giving immediate relief to navigation, and with the intention of again working over the stretch as soon as possible. The boat returned to Shreveport August 30, and

being unable to pass the draw of the bridge on account of shoaling of the channel, soundings were taken and preparations made for the construction of a temporary wing dam at that place. Authority of the Chief of Engineers having been obtained by telegraph, the wing dam was commenced September 1 and completed September 12. The work was done by the *Howell* and crew, aided by the snag boat *Breck*, on which a pile-driver was rigged; and the dam, about 250 feet in length, extending from the right bank to the west pier of the draw span, was built of piles and filled with brush weighted by sacks of earth, and, upon its completion, the ensuing scour gave sufficient depth of water and immediate relief to navigation through the draw.

Desiring to inspect the work at a low stage, I made the trip on the *Howell* from Shreveport to the mouth, September 11–19, 1893, accompanied by Assistant Engineer H. M. Marshall. The United States dredge *Lone Star* and barges were taken in tow at Alexandria to be delivered at Catahoula Shoals on the Ouachita. The water had just fallen below zero on the Shreveport gauge when we started, and though the *Howell* drew 30 inches we were not detained until we reached Prudhomme Bar, 152 miles below, where, by reason of caving and shifting bars, a wide river had formed without any defined channel, and the left bank was caving rapidly. The *Howell* was delayed one day on the bar, but worked off without parting a line, reached Alexandria at noon September 16, and took the dredge and 2 barges in tow, the dredge having been trimmed to draw 3 feet. The tow grounded at Cassandria the following afternoon, but was got off the morning of September 18, and reached the mouth of Black River at 11.30 a. m. September 19. I went on down to see the obstructions at mouth of Red River, returning next morning to take the dredge and barges to Catahoula Shoals.

September 25 the *Howell* returned to Red River, and between that date and October 27 snagging operations were carried from the mouth of Black River to Shreveport. Through the stretch known as "the Rapions" a good channel was cleared, but, as the banks are too heavy for their foundations and at low water force the unbalanced bottom up, only temporary relief was expected from the work. October 2–6 the boat worked at the bar at Snaggy Point, on which there was a depth of only 1½ feet, with river falling. All snags were removed from the channel and a short brush wing dam was built from the left bank, which scoured a channel 2½ feet deep. October 7 a slight rise set in and the *Howell* had no difficulty in crossing the bars above; the least depth found on Prudhomme Bar having been 6 feet (Alexandria gauge, 58 miles below, reading 3.5 feet). October 21–26 the stretch known as "Little River," from Knox Point to the Scopini Cut-off, was worked over. The wreck of the steamer *Texarkana*, sunk in 1869, on edge of channel about one-half mile above Magenta, was broken up and the outer half removed. On reaching Shreveport, October 27 (gauge reading 0.10 foot below zero), soundings were taken through the draw and 3½ feet depth found in the channel, and the *Howell* passed the bridge without trouble.

After undergoing necessary minor repairs, the *Howell* left Shreveport October 31 for work in the river above, where it was employed until December 2. During this period the river through the old raft region was at the lowest stage known, and to use the language of the master of the *Howell*, "The stern of the snag boat was the head of navigation." Probably the most valuable work that has been done since the great raft was removed was accomplished. The river was dammed at frequent intervals by wrack heaps or nests of logs, snags, and stumps, through

which a channel was cleared. The master of the *Howell* reported that the bottom of the raft formation appeared to have been reached at these places, as no logs could be found with the drag chain. The removal of these obstructions was followed by a swift current and rapid scour until the confined water ran out. The local packet running above Shreveport followed the track of the *Howell*, making quick time and encountering no obstructions at the lowest stage of water known in that part of the river. Operations were carried upstream to the Hervey Canal, 10 miles below Head of Raft, and 55 miles above Shreveport. Parts of the wrecks of four steamboats and one sunken barge were removed, viz: November 11, sunken barge at Fire Point; November 16, unknown steamer at Hurricane Bluff Landing, supposed to be the *Quarrier*, sunk 185?; steamers *Patsey Miller*, sunk 1875, at Hurricane Bluff, and *Bouga Houma*, sunk 185?, just above; all large side-wheel boats, and all parts that could be reached were removed; and November 21, unknown wreck of large steamer opposite Rush Point, supposed to be the *Black Hawk*, sunk 185?, all parts of which in the way of navigation were removed. These wrecks had been reported for years as no obstruction to navigation, and rarely if ever were in sight before, being one of the evidences of the incessant scour going on in the raft region.

December 3 the *Howell* returned to Shreveport, and December 5 to 7 ran down to Coushatta to tow the quarter boat left at that place by the survey party, removing a large wrack heap from the channel at Dixie December 6. On the way back the hand-propelled snag boat *Breck* was taken in tow near Halcyon Landing, and it and the quarters boat were delivered at Shreveport December 9. In passing the draw of the Shreveport bridge the *Howell* struck some submerged piling and knocked a hole in the bottom of the boat. The leak was repaired temporarily by December 14, and December 14–16 I made a trip of inspection of the river and levees from Shreveport to Blanton Bluff, 71 miles above. December 17–22 the inspection was continued from Shreveport to the mouth of the river. The survey quarter boat, left at Red River Landing in November, was towed to the plant at Catahoula Shoals, Ouachita River, and after cleaning boilers and making some minor repairs, the *Howell* resumed work at the mouth of Black River, December 26. On the trip up thorough and effective work was done; the drag chain was used constantly to locate and loosen submerged logs, and, where heavy obstructions could not be removed with the boat's machinery, high explosives were used freely, the services of a diver for the purpose having been necessary nearly every day. The stages of water remained low until January 27, and work was carried upstream to Tones Bayou, 19 miles below Shreveport. On the night of the 27th a rapid rise set in, and Sunday, January 28, the *Howell* ran to Shreveport.

As the stages of the river continued too high to work, advantage was taken of the opportunity to repair the hole knocked in the bottom of the *Howell* December 9. The small sectional dock that had been used for the purpose before was rebuilt to fit the place, pumped out, and the hole was patched with boiler iron riveted in place. Two small patches also were placed on the bow deck. This work was completed February 15, after which the small force retained was employed in caring for the *Howell* and *Breck*, overhauling the machinery, and making minor repairs.

The latter part of March the Red River Valley was visited by unusually heavy and continued rains, and March 23 orders were sent the master of the *Howell* to make a patrol of the river, to break up drift and prevent formation of jams, and, in case of emergency, to aid the

State engineers and district levee boards by carrying supplies, sacks, etc., for protecting the levee system. A crew was shipped March 24, coal, subsistence supplies, etc., taken aboard, and at 8 a. m. March 26 the *Howell* left Shreveport for the upper river. Side jams were removed at Colquitts, Jeters, Shady Grove, Cash Point, Fish Place, Butler Bend, Hurricane Bluff, Briarfield, Rush Point, and Martin Place, La., on the way up, and on reaching Cedar Bluff, 36 miles above Shreveport, March 27, it was found that a strong current was cutting into the bank and endangering the levee. A small wing dam was built with sacks of earth at the upper end of the levee, which forced the current away from the bank and relieved the danger of caving. After completing this work the boat continued upstream, removing side jams at Wild Lucia, East Egypt, and Dark Corner, a jam about half a mile in length at Scotts Slough, and three side jams between the latter place and Sale and Murphy Canal. The latter point was reached March 28, and, finding the dam and levee above in safe condition and guarded by 6 men from the vicinity, the *Howell* turned back. At Dooley Bayou the water was against the dam, and at a stage higher than in 1892 (the highest flood of previous record), but the dam was found in good condition and in no danger of breaking. On reaching Cedar Bluff the levee at that place again was found in imminent danger, increased by a high wind and heavy rain. The crew of the *Howell* worked until dark placing sacks of earth to prevent sloughing, and tied up over night at that place. The morning of March 29 the gauge indicated a slight fall, and an inspection of the levee showed it to be out of immediate danger, but there is no doubt that it would have given way if timely aid had not been rendered by the *Howell*. The boat returned to Shreveport, and as the gauge at that place read 32 feet rising (3.7 feet below high water of 1892), fears were entertained for the levees along the Little River section below, where the width is only about one-third of that at Shreveport, and the *Howell* continued downstream without delay. On reaching Richmond Bayou levee, built by the United States in 1893, it was found that a break had occurred in it near Halcyon Landing, 12 miles below Shreveport, of such extent that it was impracticable to stop it with the means at hand. At the Hall Place, below the crevasse, the boat was hailed by lights and shouts for help, and the crew was employed until midnight in rescuing men, women, and children from the submerged lands. Thirty people in all were taken aboard and cared for overnight. A deplorable incident was that of a negro man mounted on a mule, with his sick wife behind and an infant in his arms; the animal stumbled, causing the child to drop, and it was swept out of sight instantly by the rapid current, and, although immediate search was instituted, it could not be found in the night. The morning of March 30 the people who had been rescued the preceding night were landed at Sunny Point, and the *Howell* continued down to Lotus Landing, where Assistant State Engineer F. M. Kerr came aboard, and the boat returned to the crevasse, with a view to closing it or holding the ends. After taking soundings and finding it impracticable to do anything with the means at hand, the *Howell* returned to Shreveport that night. March 31 the *Howell* ran down to the Boynton levee, 15½ miles below Shreveport, carrying laborers and sacks for work at that locality, and on the return trip took aboard 29 people from submerged lands, who were transported to Curtis and Shreveport. April 1 another trip was made, carrying 5,000 sacks for use in protecting the Boynton, Staten Point, Lattier, and Magenta levees. April 2 and 3 the boat remained below the bridge at Shreveport, ready for

Money statement.

July 1, 1893, balance unexpended	$57,626.41
June 30, 1894, amount expended during fiscal year	75.41
July 1, 1894, balance unexpended	57,551.00
Amount (estimated) required for completion of existing project	1,071,090.23
Amount that can be profitably expended in fiscal year ending June 30, 1896	543,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEX., FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

Vessels using the harbor, 18 (5 steamers and 13 sailing vessels); length on deck, 36 to 220 feet; draft, 3 feet to 9 feet 4 inches; tonnage, 8 to 718 tons; trips made during the year, 144; total tonnage, 51,127 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Wool and hides	2,612	$130,600	$21,182
Lumber	2,521	30,750	9,329
General merchandise	8,826	450,018	99,158
Total	13,959	611,368	129,660

Decrease since last year, 3,464 tons.

Comparative statement of commercial statistics of Brazos Santiago Harbor, Texas, for fiscal years 1888 to 1894.

Year.	Vessels using harbor.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	12	241	10	678	126	44,741
1889	14	241	10	678	158	46,319
1890	20	219	9	717	170	40,641
1891	20	220	10.5	717	120	44,536
1892	15	220	9.4	717	127	48,724
1893	26	220	9.4	717	158	44,927
1894	18	220	9.4	718	144	51,127

Transported.

Year.	Cotton.	Wool and hides.	Lumber.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888		2,925	2,324	9,867	15,166	$737,432	$83,541
1889	130	3,080	3,188	10,885	17,283	820,315	78,140
1890	80	4,153	2,938	14,844	22,015	1,069,189	129,133
1891		3,218	2,434	15,992	21,644	1,061,082	160,215
1892		3,092	1,865	12,538	17,495	846,946	165,852
1893		2,469	2,243	12,711	17,423	811,289	159,723
1894		2,612	2,521	8,826	13,959	611,368	129,660

APPENDIX V.

IMPROVEMENT OF CERTAIN RIVERS AND WATERWAYS IN LOUISIANA, TEXAS, ARKANSAS, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO MISSISSIPPI RIVER; WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TBIBUTARIES.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Red River above Fulton, Ark.
3. Ouachita and Black rivers, Arkansas and Louisiana.
4. Bayous D'Arbonne and Corney, Louisiana.
5. Bayou Bartholomew, Louisiana and Arkansas.
6. Bœuf River, Louisiana.
7. Tensas River and Bayou Maçon, Louisiana.
8. Big Black River, Mississippi.
9. Yazoo River, Mississippi.
10. Mouth of Yazoo River, Mississippi.
11. Tchula Lake, Mississippi.
12. Tallahatchee River, Mississippi.
13. Steele and Washington bayous, Mississippi.
14. Big Sunflower River, Mississippi.
15. Big Hatchee River, Tennessee.
16. Forked Deer River, Tennessee.
17. Water gauges on Mississippi River and its principal tributaries.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 2, 1894.

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

V 1.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

The Red River of the South has its source in the *Llano Estacado*, in the panhandle of northwestern Texas, and flows in a general easterly direction, forming the boundary between Oklahoma and Indian Territories and Arkansas on the north and Texas on the south. It enters

the State of Arkansas about 10 miles north of Texarkana, and from Fulton, Ark., to Shreveport, La., its course is changed to a general southerly direction. Below the latter place its course again changes to a general southeasterly direction, and crossing the State of Louisiana it enters the Mississippi River at Red River Landing. The river is about 1,200 miles long. The part included in the project under the title of improving Red River, Louisiana and Arkansas, extends from Fulton, Ark., to the head of Atchafalaya River, Louisiana, a distance of 508.6 miles.

The importance of this great waterway was recognized by Congress as early as 1828, and appropriations for the removal of raft, amounting to more than half a million dollars, were made at intervals between 1828 and 1852. Between 1841 and 1852 no appropriation was made for continuing operations, and a longer period elapsed between 1852 and 1872, during which the results of former work were lost. The lower end of the great raft once was at Natchitoches, if not, as many suppose, still further downstream, and it extended up the river for more than 100 miles; not in an entire jam, but at intervals, with stretches of clear river between. In 1854 its head had advanced to a point about 50 miles above Shreveport, its length was 13 miles, and it was reported to be forming at the rate of 1½ to 2 miles a year. Between 1855 and 1860 the heavy rates of freight and insurance and disastrous effects of backwater from the raft became so burdensome to the planters that a corporation was chartered under the State laws for the removal of the raft; the assent of Congress was given to the method of improvement by joint resolution of February 21, 1861, and the company authorized to levy tolls for a period of thirty years. (Stat. at Large, vol. 12, p. 250.) The company was organized and preparations were made to begin work in the spring of 1861, but the war of the rebellion prevented anything being done.

The appropriations for the early work, from 1828 to 1852, were as follows:

Date of act.	General object of appropriation.	Amount.
May 23, 1828	Improving navigation of Red River through or around the raft in Louisiana and Arkansas	$25,000.00
Mar. 2, 1831	Arrearage due Maj. Burch for survey of raft of Red River, Louisiana	187.50
July 3, 1832	Improving navigation of Red River, Louisiana and Arkansas, being balance of appropriation of 1828 carried to surplus fund, and the further sum of $20,000	22,628.00
June 28, 1834	Improving navigation of Red River	50,000.00
Mar. 3, 1835	Completing removal of obstructions to navigation of Red River	50,000.00
July 2, 1836	Continuing the removal of obstructions in Red River	40,800.00
	Constructing a boat to prevent a new accumulation of obstructions in Red River within the old limits of the great raft, $15,000, and to work and support same, $15,000	30,000.00
Mar. 3, 1837	Continuing the removal of obstructions in Red River	65,000.00
Apr. 20, 1838	The complete removal of the great raft in Red River	70,000.00
Mar. 3, 1841	Removing the raft of Red River	75,000.00
Mar. 2, 1847	Deficiency of appropriation by act of Apr. 20, 1838, being amount advanced by Daniel T. Witlee and others through the branch of the Real Estate Bank of Washington, Ark., to Henry M. Shreve, Government agent, for removal of great raft and expended by him for that purpose	7,150.00
Aug. 30, 1852	Removing the raft of Red River	100,000.00
	Aggregate of appropriations, 1828–1852	535,765.50
	Amount expended	532,219.90
	Amount carried to surplus fund	3,545.60

An examination and survey of Red River from its mouth to the head of the raft were ordered by river and harbor act approved March 3, 1871, the reports of which are contained in Reports of the Chief of *Engineers for 1872*, pp. 568–573, and 1873, pp. 635–676, under which the

present improvement commenced in 1872. The original project contemplated removing the raft above Shreveport, La., and closing Tones Bayou Outlet, on the right bank, 19 miles below Shreveport, the gradual enlargement of which diverted a large quantity of water from and seriously affected navigation of the main river below. Subsequently this project was enlarged to include the removal of jams, snags, wrecks, leaning timber, etc.; opening and enlarging the channel through the falls at Alexandria, La.; deepening the channel at shoal places, and closing outlets and constructing and repairing levees to confine the river to the adopted channel, in order to improve and keep navigation open from Fulton, Ark., to the head of the Atchafalaya; also to protect the banks at Alexandria and Shreveport from erosion by the current of the river, and to make a thorough and comprehensive survey from Fulton to the Atchafalaya with a view to the permanent improvement of the river.

The appropriations for the improvement, commenced in 1872, have been as follows:

Date of act.	General object of appropriation.	Amount.
June 10, 1872	Improvement of Tones Bayou, Louisiana	$20,000
	Removing the raft in Red River, Louisiana	150,000
Mar. 3, 1873	....do	80,000
June 23, 1874	....do	50,000
Mar. 3, 1875	....do	20,000
Aug. 14, 1876	Removing the raft in Red River and closing Tones Bayou	85,000
Apr. 10, 1869	Allotment made Aug. 27, 1877, for closing Tones Bayou	4,500
Feb. 7, 1878	Opening navigation of Red River above Shreveport, La., and keeping same open and free from rafts, and for the purpose of preserving vessels of United States employed in that work	6,000
June 18, 1878	Removing raft in Red River and closing Tones Bayou	24,000
	Removing snags and other obstructions from Red River	25,000
Mar. 3, 1879	Removing raft in Red River and closing Tones Bayou	15,000
	Removing obstructions from Red River	22,500
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
June 14, 1880	Removing raft in Red River and closing Tones Bayou	25,000
	Removing obstructions from Red River, Louisiana, including construction of snag boat	60,000
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
Mar. 3, 1881	Removing raft in Red River and closing Tones Bayou	10,000
	Removing obstructions from Red River, Louisiana	10,000
Aug. 2, 1882	Continuing improvement from the Atchafalaya to Fulton, Ark., including Bayou Pierre, Tones Bayou, and to relieve the town of Alexandria from encroachments of the river	75,000
July 5, 1884	Continuing improvement from the Atchafalaya to Fulton, Ark.; not exceeding $15,000 for revetment to protect the harbor at Alexandria from damage by the current of river; not exceeding $5,000 to close the outlet known as Sale and Murphy Canal; the remainder to be applied to improvement of the main channel of the river	75,000
Aug. 5, 1886	Continuing improvement from Fulton, Ark., to the Atchafalaya River, Louisiana, including completing the work at Alexandria; $25,000, or so much thereof as necessary, to be used in making a thorough survey of the river from Fulton to the Atchafalaya, and in completing survey of Bayou Pierre, Louisiana	75,000
Aug. 11, 1888	Continuing improvement from Fulton, Ark., to the Atchafalaya River, including completing the work at Alexandria: $5,000, or so much thereof as necessary, to be used upon Cypress Bayou, and the lakes between Shreveport, La., and Jefferson, Tex., and $5,000, or so much thereof as necessary, upon Bayou Dorcheat	65,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	35,000
Sept. 19, 1890	Continuing improvement from Fulton, Ark., to the Atchafalaya River; $15,000, to be used in the work at Alexandria; $20,000 to be used in deepening and widening that portion known as Little River, from the Scopini Cut-off to Knox Point, and $5,000 in closing the Sale and Murphy outlet	100,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	28,000
July 13, 1892	Continuing improvement from Fulton, Ark., to the Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey, including the work at Alexandria, the widening of that portion known as Little River, the necessary work at the harbor at Shreveport, the closing of outlets on the west bank of the River above Shreveport, and the removal of the tow-head just above Rush Point, Caddo Parish (of which $5,000 may be used, in the discretion of the Secretary of War, for work in Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex.)	145,000
	Aggregate of appropriations, 1872 to 1894	1,175,0[illegible]

The amount expended under the project of 1872, to June 30, 1893, was $1,079,604.28 (including outstanding liabilities of $1,676.32), resulting in great benefit to navigation. In 1872 the great raft had grown to a length of 32 miles, an increase of 19 miles since 1854, extending from Carolina Bluffs, 33 miles above Shreveport, to within 4 miles of the Arkansas and Louisiana line, and, judging from the photographs taken before and during operations, one would say that it had been easier to cut through rock than to make a navigable river through the mass of tangle that grew higher and larger with every flood. The river above the raft was reached only by devious routes, through lakes and overflowed lands on either side, and canals dug by private parties, who exacted heavy tolls, and even these routes were not navigable except at stages considerably above low water. A channel was opened through the raft in 1873, and the intermittent work of the snag boats since, aided by the action of the current and by the incomplete system of levees built by the United States, the State of Louisiana, and local districts, have secured greater width and depth throughout the entire reach, with a channel-way constantly scouring, until to-day there flows in the course marked out for it a broad and deep river, safe at all but the very lowest stages, except for an occasional snag that drifts from above or a log that rises from the bottom as it scours. Moderate estimates placed the annual saving to the planting interest from the removal of the raft at $150,000, besides relieving to a great extent not less than 25,000 acres of fertile lands from overflow. (See Report Chief of Engineers, 1873, p. 665.) A comparison of levels of 1893 with those of the survey of 1872 showed that the low-water line had fallen more than 15 feet at the head of the raft, diminishing to about 3 feet at Shreveport, and that a similar reduction had been going on in the river below.

Several ineffectual attempts were made to close Tones Bayou outlet, on the right bank, 19 miles below Shreveport, but no work has been done at that point since 1882, when the dam under construction was destroyed. The outlet has been filling up gradually with drift, and this in connection with the work of the snag boats in the old raft region above and below, has caused what is known as the Little River below the mouth of the bayou, to widen and scour. Discharge observations taken twenty-one years ago gave about one-quarter to Little River, the rest escaping through Tones Bayou or over the banks into Bayou Pierre. Now fully two-thirds of the flood is carried down Little River, and as the stretch was leveed along both sides in 1893, there is no doubt that Little River will soon be able to carry the whole.

The rock excavation and dam at the Falls of Alexandria were completed in 1885, increasing the period of navigation about two months, and as a general thing permitting boats to pass the falls the year round. The passage, however, was found to be somewhat difficult at low stages, and in the low-water season of 1892–'93 dredging operations were resumed, improving the difficult piece of navigation at the Upper Falls greatly, and leaving only a small amount of work to make it safe. A crib dam and training wall were built in 1884–'85, to protect the bank in front of Alexandria from erosion by the current of the river, and in 1892–'93 this work was strengthened and the caving bank below the influence of the dam revetted with the stone excavated from the channel at the Upper Falls.

The removal of snags, logs, and wrecks from the channel and clearing the banks for the general improvement of the river from Fulton to the Atchafalaya were not begun until 1878, all former appropriations having been for the removal of the raft and closing Tones Bayou; but

35 operations have consisted chiefly of that class of work, and
ersistent efforts of the snag boats the river has been kept open,
prevented from forming again, the dangers of navigation
to a minimum, and steamboats enabled to make regular trips
owest stages of water; a condition barely hoped for when the
ment was undertaken. This work should be continued for
ears, as sunken logs and stumps are scouring loose continually
a source of great danger to low-water navigation; others,
ily water-logged, form bars impassable at low stages, and the
the upper river for hundreds of miles are covered with a
owth of timber, which is caving and sliding into the river
lly, and during high stages the amount of drift is enormous.
aft region above Shreveport jams form in a few hours often
extent, and require prompt removal before the water falls.
ng banks leave dangerous shore snags projecting far out into
am, which should be cut after every rise and fall.

ork of closing outlets and building levees to confine the river
lopted channel was begun in 1891, when the Sale and Murphy
ear the Arkansas and Louisiana line, was closed by a heavy
dam, which caused the channel through the old raft region
scour rapidly. In the fiscal year 1893 a system of levees was
ed by cooperation of the United States with the State of
a and local levee boards, extending from the hills just above
ansas State line downstream. During that year levee work
ertaken to the amount of 3,246,088 cubic yards, aggregating
in length and costing more than $550,000. Only about one-
this work was built by the United States and the proportion
st borne was less than 9 per cent.

rvey of the river was carried from Fulton, Ark., to the Atcha-
liver, and checked by a line of precise levels from Delta to
ort, La., connecting it with the Mississippi and continuing
d River from Shreveport to its mouth. This survey will not
comparison in cost, grade, or completeness with any work of
and as it had been decided to postpone or omit secondary tri-
on from the Atchafalaya back to Fulton, all that remained to
at the close of last fiscal year was the making of transvalley
and borings, the determination of high and low water limits
harge, reconnoissances to note changes since the work com-
and the completion and publication of the maps. The value
rvey was tested practically in 1893 by the State engineers of
a in locating new levees from blue prints of the maps, on
e preliminary lines were marked and profiles constructed from
ations noted on them and the grade fixed by the high-water
892 furnished by this office. The State engineers reported
e maps were practical working drawings, and that they found
ny changes necessary in laying out the lines in the field. Thus
ne and money were saved, and they were enabled to put so
amount of work under contract.

ted heretofore, whatever plan may be adopted for the perma-
provement of Red River, or even if the work of giving an
reasonable navigation to Shreveport and beyond be delayed
e, there are certain general principles to be followed, if only
ill that time comes what has been gained, or to prevent the
sing. These principles are stated in natural sequence, as

systematic clearing *of the banks* for some distance back, far

beyond the limits of this district. It is cheaper to remove the source of drift than to dispose of the drift itself, and the benefit to navigation is immediate.

2. An efficient snag-boat service for general work, patrolling the river, preventing jams, removing snags and logs from the channel and banks, and dredging towheads and obstinate shoals. Here, again, the benefit is immediate. A permanent appropriation of not less than $25,000 a year is needed for this purpose.

3. Extending the scope of the survey to embrace the whole valley. This is necessary to the proper study of this river and tributaries, and to furnish all the information required to decide upon a system of improvement and to locate its elements.

4. Construction of a substantial system of levees to restrain the greatest floods, either alone or in conjunction with the riparian States.

5. Closing gradually every outlet through which the main stream is depleted at various stages above low water.

6. Fixing caving banks to confine the main stream to the channel selected for it. Ordinarily fixing caving banks should precede levee building and closing outlets, but as the banks are reasonably stable for a considerable part of Red River, and as the object is to get improved navigation without unnecessary delay, revetment is placed after them.

7. To exercise a watchful care from first to last to prevent injury to the regimen of the river by cut-offs or outlets, and to keep the building of bridges within reasonable bounds.

During the fiscal year ending June 30, 1894, operations were continued as follows:

GENERAL IMPROVEMENT.

July 6, 1893, the United States snag boat *C. W. Howell*, M. B. Lydon, master, left Shreveport for Alexandria, La., reached the latter place July 8, and from that date to July 12 was employed in towing the hand-propelled snag boat *Harry Breck* to Shreveport, to have it ready for work in the river above. July 13 the *Howell* commenced snagging operations, and between that date and July 27 they were carried upstream to the Head of Raft, 65 miles above Shreveport. This stretch of river was worked over thoroughly, and all obstructions that could be found were removed. The sweep-chain was dragged over the entire distance, and a large number of logs were dislodged from the bottom and destroyed. The wreck of the steamer *Friendly*, sunk October 8, 1892, at Douglas Place, La., was removed entirely; of the wreck of the steamer *Phil. E. Chappell*, sunk in 1888 at White Hall, the wheel, shaft, pitmen, cylinder timbers, and all other parts that could be reached, were removed; and the cylinders and cylinder timbers of the wreck of the steamer *Monterey*, sunk in 1863 near Moultrie, La., were removed. July 28 to August 3 the *Howell* remained at Shreveport undergoing minor repairs, and the crew assisting in the construction of a flatboat for use of the survey party. The latter date it left for Alexandria, to work upstream over the stretch of river between those places, reached Alexandria Sunday, August 6, and commenced working back the following day. On account of complaints, by steamboat men, of a large number of snags in the channel, operations were carried upstream as rapidly as possible, and only the worst obstructions removed, with a view to giving immediate relief to navigation, and with the intention of again working over the stretch as soon as possible. The boat returned to Shreveport August 30, and,

being unable to pass the draw of the bridge on account of shoaling of the channel, soundings were taken and preparations made for the construction of a temporary wing dam at that place. Authority of the Chief of Engineers having been obtained by telegraph, the wing dam was commenced September 1 and completed September 12. The work was done by the *Howell* and crew, aided by the snag boat *Breck*, on which a pile-driver was rigged; and the dam, about 250 feet in length, extending from the right bank to the west pier of the draw span, was built of piles and filled with brush weighted by sacks of earth, and, upon its completion, the ensuing scour gave sufficient depth of water and immediate relief to navigation through the draw.

Desiring to inspect the work at a low stage, I made the trip on the *Howell* from Shreveport to the mouth, September 11–19, 1893, accompanied by Assistant Engineer H. M. Marshall. The United States dredge *Lone Star* and barges were taken in tow at Alexandria to be delivered at Catahoula Shoals on the Ouachita. The water had just fallen below zero on the Shreveport gauge when we started, and though the *Howell* drew 30 inches we were not detained until we reached Prudhomme Bar, 152 miles below, where, by reason of caving and shifting bars, a wide river had formed without any defined channel, and the left bank was caving rapidly. The *Howell* was delayed one day on the bar, but worked off without parting a line, reached Alexandria at noon September 16, and took the dredge and 2 barges in tow, the dredge having been trimmed to draw 3 feet. The tow grounded at Cassandria the following afternoon, but was got off the morning of September 18, and reached the mouth of Black River at 11.30 a. m. September 19. I went on down to see the obstructions at mouth of Red River, returning next morning to take the dredge and barges to Catahoula Shoals.

September 25 the *Howell* returned to Red River, and between that date and October 27 snagging operations were carried from the mouth of Black River to Shreveport. Through the stretch known as "the Rapions" a good channel was cleared, but, as the banks are too heavy for their foundations and at low water force the unbalanced bottom up, only temporary relief was expected from the work. October 2–6 the boat worked at the bar at Snaggy Point, on which there was a depth of only 1½ feet, with river falling. All snags were removed from the channel and a short brush wing dam was built from the left bank, which scoured a channel 2½ feet deep. October 7 a slight rise set in and the *Howell* had no difficulty in crossing the bars above; the least depth found on Prudhomme Bar having been 6 feet (Alexandria gauge, 58 miles below, reading 3.5 feet). October 21–26 the stretch known as "Little River," from Knox Point to the Scopini Cut-off, was worked over. The wreck of the steamer *Texarkana*, sunk in 1869, on edge of channel about one-half mile above Magenta, was broken up and the outer half removed. On reaching Shreveport, October 27 (gauge reading 0.10 foot below zero), soundings were taken through the draw and 3½ feet depth found in the channel, and the *Howell* passed the bridge without trouble.

After undergoing necessary minor repairs, the *Howell* left Shreveport October 31 for work in the river above, where it was employed until December 2. During this period the river through the old raft region was at the lowest stage known, and to use the language of the master of the *Howell*, "The stern of the snag boat was the head of navigation." Probably the most valuable work that has been done since the great raft was removed was accomplished. The river was dammed at frequent intervals by wrack heaps or *nests of logs*, snags, and stumps, through

which a channel was cleared. The master of the *Howell* reported the bottom of the raft formation appeared to have been reached at places, as no logs could be found with the drag chain. The remo these obstructions was followed by a swift current and rapid scour the confined water ran out. The local packet running above Sh port followed the track of the *Howell*, making quick time and en tering no obstructions at the lowest stage of water known in that of the river. Operations were carried upstream to the Hervey C 10 miles below Head of Raft, and 55 miles above Shreveport. of the wrecks of four steamboats and one sunken barge were rem viz: November 11, sunken barge at Fire Point; November 16, unk steamer at Hurricane Bluff Landing, supposed to be the *Quarrier*, 185?; steamers *Patsey Miller*, sunk 1875, at Hurricane Bluff, and *H Houma*, sunk 185?, just above; all large side-wheel boats, and all that could be reached were removed; and November 21, unknown v of large steamer opposite Rush Point, supposed to be the *Black H* sunk 185?, all parts of which in the way of navigation were rem These wrecks had been reported for years as no obstruction to na tion, and rarely if ever were in sight before, being one of the evid of the incessant scour going on in the raft region.

December 3 the *Howell* returned to Shreveport, and Decembe 7 ran down to Coushatta to tow the quarter boat left at that pla the survey party, removing a large wrack heap from the chan Dixie December 6. On the way back the hand-propelled snag *Breck* was taken in tow near Halcyon Landing, and it and the qu boat were delivered at Shreveport December 9. In passing the of the Shreveport bridge the *Howell* struck some submerged pilin knocked a hole in the bottom of the boat. The leak was repaired porarily by December 14, and December 14–16 I made a trip of in tion of the river and levees from Shreveport to Blanton Bluff, 71 above. December 17–22 the inspection was continued from Shrev to the mouth of the river. The survey quarter boat, left at Red Landing in November, was towed to the plant at Catahoula Sl Ouachita River, and after cleaning boilers and making some r repairs, the *Howell* resumed work at the mouth of Black River, D ber 26. On the trip up thorough and effective work was done; the chain was used constantly to locate and loosen submerged logs, where heavy obstructions could not be removed with the boat's ma ery, high explosives were used freely, the services of a diver fo purpose having been necessary nearly every day. The stages of v remained low until January 27, and work was carried upstrea Tones Bayou, 19 miles below Shreveport. On the night of the 2 rapid rise set in, and Sunday, January 28, the *Howell* ran to Shrev

As the stages of the river continued too high to work, adva was taken of the opportunity to repair the hole knocked in the bo of the *Howell* December 9. The small sectional dock that had used for the purpose before was rebuilt to fit the place, pumped and the hole was patched with boiler iron riveted in place. Two patches also were placed on the bow deck. This work was comp February 15, after which the small force retained was employ caring for the *Howell* and *Breck*, overhauling the machinery, and m minor repairs.

The latter part of March the Red River Valley was visited by u ally heavy and continued rains, and March 23 orders were sen master of the *Howell* to make a patrol of the river, to break up and prevent formation of jams, and, in case of emergency, to ai

State engineers and district levee boards by carrying supplies, sacks, etc., for protecting the levee system. A crew was shipped March 24, coal, subsistence supplies, etc., taken aboard, and at 8 a. m. March 26 the *Howell* left Shreveport for the upper river. Side jams were removed at Colquitts, Jeters, Shady Grove, Cash Point, Fish Place, Butler Bend, Hurricane Bluff, Briarfield, Rush Point, and Martin Place, La., on the way up, and on reaching Cedar Bluff, 36 miles above Shreveport, March 27, it was found that a strong current was cutting into the bank and endangering the levee. A small wing dam was built with sacks of earth at the upper end of the levee, which forced the current away from the bank and relieved the danger of caving. After completing this work the boat continued upstream, removing side jams at Wild Lucia, East Egypt, and Dark Corner, a jam about half a mile in length at Scotts Slough, and three side jams between the latter place and Sale and Murphy Canal. The latter point was reached March 28, and, finding the dam and levee above in safe condition and guarded by 6 men from the vicinity, the *Howell* turned back. At Dooley Bayou the water was against the dam, and at a stage higher than in 1892 (the highest flood of previous record), but the dam was found in good condition and in no danger of breaking. On reaching Cedar Bluff the levee at that place again was found in imminent danger, increased by a high wind and heavy rain. The crew of the *Howell* worked until dark placing sacks of earth to prevent sloughing, and tied up over night at that place. The morning of March 29 the gauge indicated a slight fall, and an inspection of the levee showed it to be out of immediate danger, but there is no doubt that it would have given way if timely aid had not been rendered by the *Howell*. The boat returned to Shreveport, and as the gauge at that place read 32 feet rising (3.7 feet below high water of 1892), fears were entertained for the levees along the Little River section below, where the width is only about one-third of that at Shreveport, and the *Howell* continued downstream without delay. On reaching Richmond Bayou levee, built by the United States in 1893, it was found that a break had occurred in it near Halcyon Landing, 12 miles below Shreveport, of such extent that it was impracticable to stop it with the means at hand. At the Hall Place, below the crevasse, the boat was hailed by lights and shouts for help, and the crew was employed until midnight in rescuing men, women, and children from the submerged lands. Thirty people in all were taken aboard and cared for overnight. A deplorable incident was that of a negro man mounted on a mule, with his sick wife behind and an infant in his arms; the animal stumbled, causing the child to drop, and it was swept out of sight instantly by the rapid current, and, although immediate search was instituted, it could not be found in the night. The morning of March 30 the people who had been rescued the preceding night were landed at Sunny Point, and the *Howell* continued down to Lotus Landing, where Assistant State Engineer F. M. Kerr came aboard, and the boat returned to the crevasse, with a view to closing it or holding the ends. After taking soundings and finding it impracticable to do anything with the means at hand, the *Howell* returned to Shreveport that night. March 31 the *Howell* ran down to the Boynton levee, 15½ miles below Shreveport, carrying laborers and sacks for work at that locality, and on the return trip took aboard 29 people from submerged lands, who were transported to Curtis and Shreveport. April 1 another trip was made, carrying 5,000 sacks for use in protecting the Boynton, Staten Point, Lattier, and Magenta levees. April 2 and 3 the boat remained below the bridge at Shreveport, ready for

call in case of emergency, but April 4, a fall having set in, it returned to the moorings with the fleet in Cross Bayou, and the crew was discharged.

The following is a summary of the work done during the year by the snag boat *Howell* for improving navigation of Red River:

Snags pulled	1,835
Stumps pulled	352
Shore snags cut	304
Logs removed from channel	4,790
Mud lumps destroyed	1
Jams removed	1
Side jams removed	26
Leaning trees cut	615
Lineal feet of wing dams built	285

Wrecks removed, viz: All of steamer *Friendly*, sunk 1892; part of steamer *Phil E. Chappell*, sunk 1888; part of steamer *Monterey*, sunk 1863; part of steamer *Texarkana*, sunk 1869; sunken barge at Fire Point; parts of two unknown steamers at Hurricane Bluff and Rush Point; part of steamer *Patsey Miller*, sunk 1875; and part of steamer *Bouga Houma*, sunk 185?.

During the months of April, May, and June the stages were too high, during the greater portion of the time, for effective work for the removal of obstructions to navigation, and advantage was taken of this period to make needed repairs of the *Howell* and machinery.

The hand-propelled snag boat *Harry Breck*, Robert Elflein, overseer, in charge, left Shreveport July 13, commenced work at Herndon Place, about 2 miles above, which was continued until September 2 and carried upstream to Alban Canal No. 1, 56½ miles above Shreveport. During this period the water was at a low stage, the gauge at Shreveport ranging from 1 to 6 feet above zero, but being below 3 feet the greater portion of the time. Operations consisted of clearing both banks of caving and sliding timber, and removing shore snags, stumps, etc. Work generally was under the banks, and only such trees and stumps on the top banks as were in imminent danger of caving into the river were cut. Felled trees were cut into short lengths, so they would dry and float out on the first flood. All shore snags and stumps that could be reached were cut, and explosives were used with advantage in removing those in the water. Above Gilmer the banks had been caving rapidly, extending in places beyond the clearing done by the crew of the *Breck* in 1891, and at such points the top banks were worked over and the trees and brush cut away for distances ranging from 40 to 60 feet back from the river. Where there was little caving the timber was deadened for a distance of 20 to 30 feet.

The *Breck* having been ordered to Shreveport to aid in constructing the wing dam at that place, started downstream the afternoon of September 2 and reached Shreveport the morning of September 4, where it was employed as a pile-driver until September 12. From the latter date until November 8 it was employed in Cypress Bayou and the lakes, the report of which will be found under that head.

November 9 the *Breck* returned to Red River and was employed on the stretch below Scopini Cut-off to Knox Point, known as the Little River, until December 9, when it was towed to Shreveport by the snag boat *Howell*. During this period the stages of river were near extreme low water, the gauge at Shreveport during the entire month of November reading from 1 to 2.6 feet below zero. This stretch of river was worked over thoroughly going down, and the obstructions missed were removed on the way back. The wrecks of the steamers *Texarkana*, sunk 1869 one-half mile above Magenta, part of which had been removed by the *Howell* in October, and the *Express Mail*, sunk 1849 at Bates

Bend, were exposed by the extreme low stage of water and were destroyed with explosives.

The following is a summary of the work done by the *Breck* in Red River during the year, viz:

Stumps removed	2,226
Shore snags removed	9,767
Side jams removed	1
Leaning trees cut	5,173
Trees girdled	1,143
Square yards brush and willows cut	17,350
Hard clay points removed with explosives	1

Wrecks removed, viz, parts of steamers *Texarkana* and *Express Mail*.

LITTLE RIVER FROM THE SCOPINI CUT-OFF TO KNOX POINT.

During the fiscal year ending June 30, 1894, work in this stretch of Red River, 17½ miles long, under the allotment made by river and harbor act of September 19, 1890, consisted of intermittent operations with the snag boats *Howell* and *Breck* at low stages of water, in accordance with the approved project. The report of the work done is included in the continuous reports of the two boats, under the preceding head of "General improvement."

ALEXANDRIA.

The approved project for work at Alexandria contemplated improving the channel at the Upper Falls by dredging, to give greater ease and safety to the passage of boats at low stages of water, and using the material excavated for protecting the town front from erosion by the current of the river.

This work was stopped December 26, 1892, when the dredge broke down, but during the period of high water, which followed almost immediately, the boat was hauled out, the bottom repaired and calked, and the broken parts of machinery replaced, preparatory to resuming operations as soon as the water should reach a sufficiently low stage.

During the month of July, 1893, the water by the Alexandria gauge fell from 20 feet on the 1st to 6½ feet on the 31st, and August 1 operations at the Upper Falls were resumed by the U. S. dredge *Lone Star*, G. W. Phillips, engineer in charge, and were continued until September 4, 1893, when the available funds were exhausted. Sixty-seven bargeloads of the material excavated, containing 2,432 cubic yards, were floated down to Alexandria and used in raising and strengthening the crib dike built in 1884–'85, with the exception of 88 cubic yards of material used for revetting the bank at Cullen's warehouse.

The following is a summary of the work done, viz:

	Cubic yards.
Rock excavated from channel at Upper Falls	3,483
Rock transported in barges to front of Alexandria and used for raising and strengthening crib dike and revetting caving bank	2,432

After suspending operations the dredge and barges were towed to Catahoula Shoals, Ouachita River, for work at that place.

CONSTRUCTION OF LEVEES.

The levee work in progress at the end of the fiscal year 1893 was completed, as follows:

The Blanton Bluff and Bargetown Levee was completed August 15, 1893, under extension of contract with Dordan & Hunt, at the rate

of 14½ cents per cubic yard. The line extends from the high land on right bank of the river at Blanton Bluff, Ark., 70¾ miles above Shreveport, La., downstream 9,389 feet to a junction with the Bargetown Levee built by the State of Louisiana in 1891–'92. Final measurement showed the total contents of the levee to be 126,060.3 cubic yards.

The railroad to Mack Bayou Levee was completed by Contractor John T. Martin September 20, 1893. This line extends from the railroad embankment opposite Shreveport, La., downstream 4,829 feet to upper end of Vinson Bayou Levee, and from lower end of that levee downstream 7,300 feet to and across Mack Bayou. The total amount of embankment built was 57,700 cubic yards, at a cost of $5,085, of which the United States paid $2,000, the Bossier Levee board $2,500, and the State of Louisiana $585.

Between August 28 and September 21, 1893, stone was hauled to the Sale and Murphy Dam for strengthening that structure. One hundred and thirty-seven wagonloads, averaging about one-half a cubic yard to the load, were placed on the dam as follows: 61 loads for riprapping lower end, 50 loads for revetting mattress on river side, and 26 loads for revetting mattress on land side.

It had been the intention to apply the available balance to clearing the right of way from the Sale and Murphy Dam southward, preliminary to the construction of a levee to join the line projected by the State engineers below. I made an inspection of the locality in August, but learned that the State could not undertake to lay out the proposed line below the dam during the year. After consultation with Assistant State Engineer Kerr upon the subject, it was agreed that it was of first importance to make the line from Blanton Bluff to the dam secure by repairing and enlarging the Bargetown Levee built by the State in 1891–'92. Recommendation to this effect having been approved by the Chief of Engineers, the work was advertised by circular letter September 30, and the following proposals were received and opened at the U. S. engineer office, Vicksburg, Miss., at 12 o'clock noon October 14, 1893, viz:

No.	Name and address of bidder.	Price per cubic yard.
		Cents.
1	John T. Martin and Michael Hunt, Shreveport, La	22.8
2	Thomas J. Martin, Missionary, La	26

Contract was made with Martin & Hunt October 21, and the work was finished by them December 9, consisting of strengthening the levee and bringing to grade of 3 feet above high water of 1892, requiring 21,000 cubic yards of embankment.

This work exhausted the funds available for levee work.

During the flood of March and April, 1894, 58 gauges, which had been set by levels from permanent monuments, were read along Red River, in addition to the 7 permanent gauges, supplemented by the reports of rainfall, etc., from the Weather Bureau. The plotted results to the same plane of reference show that the high-water line of 1894 behaved like that of 1892 with respect to previous floods; rose above at some points and fell below at others. At Shreveport the maximum of 34.5 feet was recorded April 2, 1894, as against 35.7 feet May 28, 1892, but I have little doubt that the flood of 1894 would have passed the latter height from the enormous rainfall in the upper valley,

except for the great scour that had been going on in the reach as shown by soundings made at the top of the flood at the bridge and in front of the city. The discharge was not measured this spring, but from the great increase of section at Shreveport, and observed current, it is hardly to be doubted that it exceeded that of 1892, which was 6,400 cubic meters per second. Notwithstanding the great height and force of the flood of 1894, the levees withstood the water without serious damage except at two places, viz: The crevasse in the Richmond Bayou Levee, built by the United States the early part of 1893, caused by the cutting or caving of the old outside levee at Lay Bayou, which had been held until a critical moment, and then the full force of the current let against the new line March 29, which succumbed in a short time. A break occurred April 1 in the Cash Levee at Navigator Point, built by the Caddo Levee district the early part of 1893, which was due to faulty construction of a drainage siphon. As soon as information of the break in the Richmond Bayou Levee was received at this office, the matter was referred to the U. S. attorney for the western district of Louisiana, under section 11 of the river and harbor act of 1890, for investigation, as it had been stated that the cut was made by unauthorized individuals when the time, locality, and conditions could not have been worse chosen, which statement was denied, and it was alleged that the breaking of the old levee was due to natural caving of the river bank.

As it was impracticable for the United States to attempt to close the crevasse in the Richmond Bayou Levee with the small balance available for levee work, and as the people affected thereby naturally were much concerned over the possibility of another flood, and were unable themselves to rebuild in time to prevent a recurrence of the disaster in case of flood, upon the recommendation of the State engineers, the work of closing this crevasse, the one in the Cash Levee, and the repair and enlargement of the Riverdale to Tones Bayou Levee in Caddo Parish, which suffered considerably during the high water, was advertised by the governor of Louisiana April 15, placed under contract the latter part of that month, and both crevasses were closed in May.

The following table, furnished by the board of State engineers of Louisiana, shows in a concise manner the work on Red River undertaken during the fiscal year by the State and local levee districts.

Tabulated statement showing levee work on Red River undertaken by the State of Louisiana and local levee districts under contracts entered into during the fiscal year ending June 30, 1894.

Name of contract.	Parish.	Date of—		New levee (12 miles).	Enlargement (25 miles).	Quantity.	Price, per cubic yard.	Cost.		Per cent of work done.
		Contract.	Final certificate.					District fund.	General engineer.	
Caddo Levee district.										
By the State:				*Lin. ft.*	*Lin. ft.*	*Cu. yds.*	*Cents.*			
Rush Bayou enlargement*	Caddo	Aug. 23, 1893	Nov. 6, 1893	650	10,040	44,439	13.38		$5,945.93	100
Cash crevasse†	do	Apr. 27, 1894		1,120	3,430	31,713	10.99		3,485.26	50
Riverdale to Tones Bayou	do	Apr. 24, 1894		500	9,375	43,098	12.97		5,589.81	35
Total				2,270	22,845	119,250			15,021.00	
By the district:										
Cavitt and Dole	Caddo		Jan. 2, 1894		18,560	40,966	22.50	$9,217.35		100
Coushatta and Dooley Bayou	do		Nov. 16, 1893		7,310	14,005	27	3,781.35		100
Egypt	do		Jan. 8, 1894		14,968	32,297	12.035	5,886.94		100
Wild Lucia	do		do		9,700	16,068	12.07	1,939.40		100
Crescent and Cedar Bluff	do		do		15,537	31,906	11.75	3,748.95		100
Eagle Bend	do		Dec. 8, 1893		5,304	13,590	10.74	1,459.57		100
Cash and Pascagoula	do		do	2,375	1,445	14,297	9.95	1,422.55		100
Total				2,375	72,824	163,129		25,456.11		
Bossier Levee district.										
By the State:										
Hurricane Bluff to Willow Chute	Bossier	Jan. 26, 1894	May 21, 1894	12,463		73,943			6,500.00	100
Schenicks Bayou extensions‡	do		May 14, 1894	5,962	20,852	98,946	9.95		9,845.12	100
Richmond Bayou crevasse§	do	Apr. 24, 1894		1,470	855	30,441	14.50		4,413.94	100
Total				19,895	21,707	203,330			20,759.06	
By the district:										
Hurricane Bluff to Willow Chute	Bossier	Jan. 26, 1894	May 21, 1894	4,793		28,440		2,500.00		100
Red River, Atchafalaya and Bayou Boeuf Levee district.										
By the State:										
Connella	Rapides	June 13, 1894		1,845	3,485	50,000±	9.98		4,990.00	
Dorman	do	do		3,572	1,163	50,000±	9.44		4,720.00	
Wilson	do	do		6,378	4,710	100,000±	10.75		10,750.00	
Total				11,795	9,358	200,000±			20,460.00	

By the district:											
Hudson	Rapides	Oct. 5, 1893	May 3, 1894	7,275	.....	125,057	14	17,507.98	.....		100
Tramway to Connella	do	do	Mar. 19, 1894	4,314	3,430	94,902	13.49	12,802.27	.....		100
B. T. Lewis	do	Sept. 21, 1893	Apr. 5, 1894	2,385	1,080	32,323	10.85	3,507.04	.....		100
Rogers	do	Oct. 5, 1893	Mar. 22, 1894	3,598	.....	48,000	13.3	6,403.80	.....		100
Egg Bend	Avoyelles	Sept. 21, 1893	Feb. 10, 1894	4,737	.....	80,758	14.375	11,608.96	.....		100
Total				22,309	5,119	381,040	.....	51,890.05	.....	.....	
Total work undertaken				63,437	131,853	1,095,789	.....	79,846.16	56,240.06	.....	

* Includes enlargement at Ferryfield.
† Includes Peace Point section of Cash crevasse completed.
‡ Includes work at Clays, Halls, Sunflower, Chalk Level, and Bossier City.
§ Completed, but settlement deferred.

CYPRESS BAYOU AND THE LAKES BETWEEN SHREVEPORT, JEFFERSON, TEX.

The act of July 13, 1892, provided that $5,000 of the appr for Red River might be used, in the discretion of the Secretary for work in Cypress Bayou and the lakes between Shrevep and Jefferson, Tex. While I was at Shreveport, Septembe 1893, the steamboat men interested in the trade between Sh and Jefferson urged the removal of stumps, etc., from the during the low stage of water. Assistant Engineer H. M. Mars sent to examine the lower lake route, and reported that the fl bare and the conditions most favorable for blowing out the st the channel. I ordered Overseer Elflein to work the snag bo up Twelve-Mile Bayou to the foot of the lakes, and then to pu ations with a chopping party, quartered in tents, upstream as as possible through the lakes and bayou to Jefferson. On m to Vicksburg, after inspecting Red and Ouachita rivers, I repo action, and the plan was approved by Department letter of Se 27.

The snag boat *Breck* left Shreveport September 12, and Twelve-Mile Bayou and commenced work the same day. On Hammond Place, between the 9 and 10 mile posts, it was fo the boat could go no farther on the low stage of water, and it up in a deep pool. Operations were pushed upstream by the c party, using explosives freely for the removal of stumps, etc., carried to Jefferson by October 20. At Jefferson the outfit wa in the skiffs and a small flatboat, and the party started bac stream October 21, and reached the snag boat *Breck* the ev October 22. October 23 to November 8 the party was employed ing heavy timber on caving banks of Twelve-Mile Bayou, on co of which work it was transferred to the Little River below Sh

The following is a summary of the work done between Sh and Jefferson, viz:

Snags and logs removed from channel	
Stumps removed	
Tow-heads destroyed	
Shore snags removed	
Leaning trees cut	
Trees girdled	
Square yards willows and brush cut	

Wrecks removed, viz: *Lizzie Lee*, sunk 1871 in Twelve-Mile Bayou; an sunk 1857, and *Texas* and *Juberquit*, dates unknown, near Albany. All u of these wrecks were destroyed, only floor timbers and bottom plank r which will not obstruct navigation in the least.

DISCUSSION OF IMPROVEMENT AND ESTIMATES.

The survey of the Red River from Fulton, Ark., to the Atc a distance by channel measurement of 818.5 kilometers (508.6 nearly finished. The details of the year's work are given in th of Assistant Engineer Marshall herewith.

It would be more valuable for geographical purposes if the se triangulation and the transvalley sections could be carried neither are absolutely necessary, for the study of the best m improvement does not require the former, and the fact that both States and State engineers are in perfect accord upon the su confining the river by closing outlets and building levees ren

mall moment what material lies on either side the immediate banks, or whether the lands rise or fall away. We know the general fall of the valley from Fulton to the Mississippi, and we have the most exact information that has been obtained on any river of like magnitude of the fall per unit of the water surface at extreme stages. The rapid reconnoissance of 1893, rapid because the frequency of permanent reference points of triangulation and elevation enabled the parties to get definite information without delaying to identify positions where changes had taken place, has been developed upon the office maps, from which we may get an accurate measure of the amount of change at any point and the time.

The river as a whole has improved vastly since the raft was destroyed, both as a navigable stream and as a drain for the great valley through which it flows. The intermittent but frequent attacks of the snag boats upon the remains of the raft as they were uncovered by scour have given way for the eroding action of the river, so that it is navigable at far lower stages than was possible even so short a time as five years ago; and at present at very low stages, say, barely a foot above zero at Shreveport, the river is open to all boats of 3-foot draft from Fulton to the Mississippi, except for the bar at the mouth.

A report of the Weather Bureau of February 24, 1894, stated the results thus:

> On August 22, 1888, the stage at Shreveport was 4.7 feet above zero. On that date boats could not run. On October 1 and 2, 1893, the stage was 2.6 feet below zero, or 7.3 feet lower than on August 22, 1888, and boats were able to run.

The bottom of the river in the raft region above Shreveport has gone down as much as 15 feet, the low-water line following it to a certain extent, and a similar process has been going on below, especially in the stretch known as Little River. The effect has been to lower the general low-water limit, increase the depth, and give a greater carrying power to the whole river. It might be expected that the high-water line should follow the general improvement, but the development of the valley, denuding it of timber, and the accompanying reclamation of lands by drainage, have changed the conditions to such a degree that the rainfall is no longer held back to filter through the soil or drain slowly into the river, but is precipitated into it with a rush, so that while the total flow may be about the same one year with another, the amount discharged per second in time of flood is far greater than formerly.

A high water of 35 feet on the Shreveport gauge now means a volume of discharge that could not have been carried by the river in 1849, 1866, or 1874, noted high-water years that old settlers refer to. One has only to examine the old channels now cut off, like Lattier, to judge how inadequate the section of discharge would have been even for a flood of far less volume than those of recent years. The abandoned channels have not changed, except perhaps to widen slightly from the wash of local rains; certainly they have not closed in, as may be judged by large old trees that mark the opposite banks; but they look so small as compared with the main river that it seems hard to believe they once formed part of it and were navigable at certain stages by the large side-wheel boats of those days.

The gradual closing of outlets and the building up of the levee system, now fully under way, must combine with the speedier delivery of the rainfall to keep the high-water line up until the river shall have scoured a channel large enough to carry it, and then we may expect a gradual reduction of flood heights, provided means are taken in time to

prevent waste of energy in caving banks and consequently diminishing the slope below a proper working limit.

The time seems near at hand when the permanent improvement of navigation by an open river should be undertaken, and therefore for a proper study of the problem the maps should be published on the original scale of 1:10,000 for working drawings, and upon some convenient smaller scale for comprehensive views of long stretches from which a correct idea may be had of the relation of the various parts and the probable effect of local work upon the bends at a distance above and below.

The first and most important question to be decided is the general plan of improvement. On the one hand those interested in navigation wish the work to begin at the lower end and the worst places improved first, so that as much of the river as possible may be open for use in the shortest time. But, on the other hand, it may be doubted if this would be the best means of making a permanent improvement of the river as a whole. The bad places may be either parts of an unformed or of a deformed river. If the former, we may expect gradual improvement by natural action, while in the latter case temporary expedients may answer for some length of time.

There are considerable stretches of Red River where the banks are fairly stable and the depth sufficient for navigation at all stages which may be left without much attention, except to watch carefully for changes, while there are others in which the river has worked into a condition that would be almost perfect if it could be fixed and made permanent now, but which may be deformed by caving banks or cut-offs and require long periods for restoration. It seems to me that the leading principle should be to attack those reaches where the river by its own force has nearly reached its best; where the section is ample for the greatest flood, the depth good at low stages, the banks of easy curvature, the slope well established; and to join them later on with parts above and below as they develop under the natural action of the river or by properly directed assistance as occasion seems to offer.

At first blush it might be thought that such a plan would involve an incomputable expenditure, while it would cause great impatience among river men; but it is not at all clear that the cost would be lessened by concentrating energy upon the worst places, producing violent changes of regimen which must have an unfavorable influence upon those parts which may be already good. Whatever method be judged best, it must be admitted frankly at the outset that any plan for the improvement of a navigable stream in an alluvial valley will cost a large amount, no matter how carefully thought out or how well administered. The practical business questions for answer are: Will it pay the United States to improve this part of its property? Will the work benefit the people at large as it progresses, increasing their facilities and cheapening rates, and consequently aid in the development of the country?

Brilliancy of results is often delusive. Slope is the controlling factor, and if a great success has been obtained over a small stretch of bad river it must be at the expense of slope above or below, and those parts correlated to the newly improved portions can not fail of injury to their regimen. It is the apparently immediate good results that lead people into the belief that dredging bars at random, cut-offs, and outlets, are the only true and practical means of improving alluvial streams. The motto for those who advocate the last two might well be "After us the deluge."

But, if it be insisted as a measure of policy, that the worst places

must be attacked first to give immediate relief and practical results, then the work should be adjusted as far as practicable to the principle laid down, and we still should try to secure the good places and extend the scope of operations in bad reaches by beginning at long distances above and extending far below them. Such a plan by no means would preclude temporary alleviation by a moderate use of the dredge or the dispersion of shoals by inexpensive spurs or dikes, or by means of floating wing dams. It would be very interesting and perhaps profitable to experiment with barges that could be moored by spuds and form a jetty by drop shutters or by plank with intervals on the upstream side; the idea being to produce moderate concentration of the flow upon shoals, and to withdraw them when sufficient depth had been gained for the time being, to repeat the operation at some other point. Anyone may build a jetty, and whether placed in the best position or not the shoal must yield; but once down it is expended and generally must remain to be covered by deposit or be washed away. The material can not be taken up to be used at some other site.

The idea of securing the river was suggested several years ago by Commissioner Harrod, who advocated the systematic revetment of the banks of Mississippi River. The idea presented here is to secure those portions of the river which are good and await the improvement of he worse parts by natural work of the river itself, assisted if need be by such expedients as will not hasten the process unduly, while satisfying the immediate needs of commerce. This subject was presented to the International Congress of the Columbian Exposition in a paper entitled "The limits attainable in improving the navigability of rivers by means of regulation," by H. Engels, professor of hydraulics in the Royal Technical High School at Dresden. It was published in vol. 29 of the Transactions of the American Society of Civil Engineers, and discussed in a following number.

Whatever be the final plan, the conditions are such that the work must be done by plant owned by the United States and by hired labor. Contracts may be made for material and supplies, but it is not practicable to draw up specifications that can be followed rigidly, however faithful and zealous the contractor. Boats will be needed for quartering and feeding men; barges for piling, brush, and stone; shopboats for all sorts of repair work; pile-drivers, steam tenders, and large boats for towing. A great outlay at first and far beyond the means of contractors, unless operations should be extended over considerable periods under continuous appropriations.

Referring to my remarks in the last report upon bank revetment, etc. (Report Chief of Engineers, 1893, p. 1910), I recommend that a beginning be made by a few additions to the working plant, say a dredge that can deposit material 100 feet away, pile-drivers, barges, and a dispatch towboat; and that the experiment begin with the reach including Shreveport and extending a mile or so above and below the city; and follow by work in some other reach of different character, say above the falls and past Alexandria.

The discharge section at Shreveport seems to be ample for any flood. Depths of 60, 70, and 90 feet were sounded during the high water of March, 1894, and though the flood height was less than in 1892 by about 4 decimeters, standing 34.5 feet on the gauge as against 35.7 feet in 1892, it is hardly to be doubted that the discharge was equal to if not greater than in the former year when it reached 6,400 cubic meters per second. To convey some notion of the volume and of its power to do good work in the channel as well as bad in destroying the banks, I

change the scale, and state that 6,400 cubic meters per second means 600,000,000 tons of water passing Shreveport bridge in twenty-four hours, of which, from the mean sediment observations, 100,000 tons were mud.

It seems strange to note in passing that while examination of the banks and shoals on the surface shows chiefly the fine red silt that gives color and name to the river, we almost always find after a serious crevasse the track of the overflow marked by sharp white sand; but the borings reveal the source, for this sand is below the superficial covering of the bars, and in time of great disturbance is whirled up from the bottom to be cast upon the land when the levees fail, or deposited in some lower reach where the velocity may be checked. This is the material to throw down upon the shores in places that are too wide, by forcing the river to build up its banks.

Levees must continue to play a decisive part in improving navigation by confining the river to the channel prescribed for it, and that they may do their full share they should be as near the banks as possible and follow the windings of the stream. Short cuts have been made and points left out, and the levees set far back; but this has been done both for want of means and for lack of stability in the banks. These facts offer further argument for fixing the banks, especially in those parts where we may pronounce the river now at its best.

The people of Red River Valley have taxed themselves for levees almost to impoverishment, and thus far the United States has done but a small part of the work; the first allotment, amounting to $57,275, being made upon my recommendation from the appropriation of 1892. I therefore recommend a large increase for levee construction, not only to help those within established levee districts, but to extend the system to those portions not yet included in State districts or under the general State allotments, and to portions beyond their jurisdiction.

Closing outlets follows naturally from the extension of the levee system; but the work should be done cautiously and slowly, and in advance of levee construction, in order to settle and give good foundations. Sale and Murphy Canal was closed three years ago, Dooley Bayou last year, and Red Bayou should be closed this season. A pause should then be made above Shreveport and the question of closing Tones Bayou taken up. It is my judgment that this work will be done best, when the proper time arrives, by building sills across and gradually raising them as judged best. The Little River does not yet seem to be quite large enough to carry all of the water, and therefore should be taxed only little by little. It is not improbable that a sill in Tones Bayou might answer even if left only at half stage for sometime. The decision should not be made in haste, but rather delayed until several floods have given opportunity to measure discharge above, in, and below the bayou, to determine the proportions, and how much may be sent down Little River without danger of overtopping the levees.

The Red, Bœuf River, and Atchafalaya district has received no help from the United States on Red River, and should have consideration, especially as the extension of the system above sends more water down upon them in a given time than formerly. But extending the line along Red River below involves cutting off a certain amount of drainage, as about Choctaw Bayou, for which provision must be made through some of the bayous in the rear that lead to the lakes and outlets toward the Gulf.

Farther down stream is a reach known as the Rapions, where drainage of the adjacent lands will be necessary to maintain a navigable chan-

el. At low stages the weight on either side the river is too great for the bed through which it flows, and the bottom is forced up in long ridges, often considerably above the surface. Here dredging would be to little purpose, since it would only remove weight from that part that is now too light. To dredge the bottom would in fact be to dig away the banks, though more slowly, since they would continue to push the bed up or slide in. Here the banks should be stripped for some distance back and ditches cut to drain the lakes and swamps on either side.

The limit of Red River under my charge is reached at the Atchafalaya. There is some talk of turning the course of this great river down the bayou, to lose itself among the lakes and overflow the swamps below, with a by-pass to reach the Mississippi by a lock at Plaquemine. If this is to be done the subject of improving the navigation of Red River may as well be dropped at once, as well as that of Ouachita and its tributaries, which supply almost as much water as the Red, and promise a system of navigation perhaps superior, in the extent of valley that may be developed and served, to that of the greater river. How the advocates of this scheme propose to take care of a discharge of at least 10,000 cubic meters per second, or if they have given this feature a thought, does not appear; but it is certain that if the systems of the Red and Ouachita are to be maintained as beneficent navigable waterways they must have free and unobstructed entrance to the Mississippi; not, as some fear, to give their "sum of more to that which hath too much," but to be absorbed and carried safely to the sea.

The whole river, and especially the upper portions, even high up in the secondary district above Fulton, will require the constant care of the snag boats for many years. In the wilder portions enormous trees will continue to cave into the river and form dangerous snags and obstructions below, and the removal of young growth along the banks, as practiced in the lower river, will prevent formations of jams to some extent and do much to make navigation safer, especially in the sharp bends. The benefit of intermittent work by the snag boats moving from place to place, and returning again to the attack after the river has scoured somewhat, has been mentioned in former reports and has been confirmed by later work. When not at work the snag boats should be kept ready to go out at short notice to prevent formation of jams, which, if neglected, might start raft formation again that would cost thousands to remove.

A liberal amount should be applied to surveys, reconnoissances, gages, and discharge measurements, to fill and perfect the information we have. Discharge at a great many critical points should be measured during floods, to get a better knowledge of the maximum section that should be required. Discharge is especially needful to be measured at extreme low stages, to determine the proper relations that will give sufficient depth for navigation at low water.

If funds could be had for the purpose it would be interesting to extend the examination of the lake region on the right bank above Shreveport, as suggested in the last report upon the survey of Cypress Bayou, and to investigate the question of establishing a reservoir to aid in case of low water, while giving a navigable route to Jefferson. (Report Chief of Engineers, 1893, pp. 2068–2071.)

In former reports and in appropriation bills special stretches have been considered as harbors, but as they are merely local names for parts of the river, and are not harbors as the term is understood, they should not receive special attention at the expense of other parts of the river where the need of work for the benefit of navigation may be

greater. If a city or river town wishes a handsome paved levee front, the corporation or some chartered body should raise the money to do the work and receive a proper return in wharfage dues. No work should be done on such fronts by the United States except in the direct interest of navigation, to give a proper depth or to prevent injury from a caving bank. Protection work would rarely take a form that could be utilized for business purposes, whether mattress and riprap, or spurs, or pile dikes. But, on the other hand, if work should be found necessary upon a city front, it would seem quite proper to modify the form somewhat, and allow the corporation to join in making so much as needed substantial and easy of access for teams and other traffic at all stages. For these reasons, though I think certain work both desirable and necessary in the reaches which include Shreveport and Alexandria, I have omitted special estimates for those places, and whatever is required to be done should come from the general allotment.

The estimates for the fiscal year 1896 are based upon the ideas set forth, to make a beginning in permanent improvement. Those for levees were derived from a statement prepared by the State engineers of Louisiana and supplemented by estimates for work beyond the State line.

Additions to plant, dredges, pile-drivers, barges, steamboats, tools, rigging, and outfit	$100,000
Care of plant, repairs, etc	20,000
Service of snag boats, dredges, and chopping parties	50,000
Closing outlets, sills, dredging for outlets for impounded water, draining lakes, etc	50,000
Two and one-quarter million cubic yards levees	450,000
Fixing and revetting bends, caving banks, dikes, spurs, etc	300,000
Surveys, gauges, discharge measurements, maps, etc	20,000
Office charges, administration, transportation, etc	10,000
Total	1,000,000

The amounts expended during the fiscal year ending June 30, 1894, and balances unexpended July 1, 1894, are as follows:

Allotments.	Expended during year.	Balances July 1, 1894.
For general improvement, repairs, care of plant, etc	$17,763.58	$23,463.76
For work at Alexandria, La	1,875.35	53.04
For Little River from Scopini Cut-off to Knox Point	2,155.52	13,727.41
For Cypress Bayou, etc	1,682.83	3,298.67
For survey of Red River	15,732.89	2,523.76
For construction of levees	14,539.49	293.05
Total	53,749.66	43,359.69

Money statement.

July 1, 1893, balance unexpended	$97,072.04
Received on account of overpayments to land-grant railroads	37.31
	97,109.35
June 30, 1894, amount expended during fiscal year	53,749.66
July 1, 1894, balance unexpended	43,359.69
July 1, 1894, outstanding liabilities	64.75
July 1, 1894, balance available	43,294.94
Amount that can be profitably expended in fiscal year ending June 30, 1896	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

During the fiscal year Red River was reported navigable to Fulton from October to June, inclusive, and from Gilmer, La., to the mouth the entire time. The mouth was open to navigation the whole year.

List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Valley Queen	Stern-wheel.	410.83	190.6	35.8	5.6	2 6	9 0	New Orleans and Shreveport, La.	10	500
Garland	do	261.42	162	30	4.8	2 0	6 6	do	13	250
Hallette	do	265.90	161	30.5	4.5	2 0	6 6	do	21	250
C. E. Satterlee	do	254.49	162	30	4.5	2 0	6 6	do	10	40
Rosa Bland	do	148.71	113.2	22.8	4.4	1 3	3 6	Shreveport and Gilmer, La.	18	54
								Shreveport, La., and Garland, Ark.	26	126
								Shreveport and Coushatta, La.	10	58
								Shreveport, La., and Jefferson, Tex.	17	65
E. B. Wheelock	do	254.49	160	30	4.9	1 8	5 6	New Orleans and Shreveport, La.	12	175
Nat F. Dortch	do	302.88	164	28.8	3.5	1 3	3 6	do	11	150
Gamma	do	44.32	84	18.4	4.3	2 6	3 6	Monroe, La., and Little River, Ark.	9	....
D. H. Pike	do	465.75	199.6	33.5	5.5	2 3	7 0	St. Louis, Mo., and Knox Point, La.	1	20
Ferd Herold	do	900.58	244.6	34	7.2	3 6	8 0	do	1	21
Cherokee	do	631.20	216.4	33.9	5.4	2 6	7 0	do	1	....
C. R. Cummings	do	41.81	62	14.6	3	1 0	2 4	Shreveport and Upper Red.	1	....
Florence	Tug	18.49	.....	.....	.....	3 0	.....	Shreveport, La., and Index, Tex.	34	....
Anna B. Adams	Stern-wheel.	315.49	157	31.6	3.1	1 6	4 6	New Orleans and Montgomery, La.	4	....
								New Orleans and Buckeye, La.	1	....
								New Orleans and Shreveport, La.	23	75
Dacotah	do	726.09	252	48.3	5.5	2 0	5 0	New Orl'eans and Coushatta, La.	1	....
								New Orleans and Panola, La.	1	....
								New Orleans and Shreveport, La.	2	....
John Howard	do	329.69	180	36	6.0	2 6	7 6	New Orleans and Knox Point, La.	1	....
								St. Louis, Mo., and Knox Point, La.	1	....
Danube	do	232.32	175	33.8	5.1	2 0	5 6	New Orleans and Coushatta, La.	1	5

The steamers *Garland* and *C. E. Satterlee* were sunk during the year.

Summary of commerce reported.

Articles.	1893-'94.	1892-'93.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	15,392	14,061	29,400	21,613	18,838	12,593
Cotton seed	4,402	7,902	31,832	12,249	14,140	11,975
Cotton-seed meal	9,042	4,713	.....	10,000	.....	.....
Live stock	496	1,185	286	38	.....	32
Hides and skins	31	62	151	212	35	97
Lumber	1,257	1,520	2,352	.....	4,519	.....
Saw logs	28,869	15,200	22,250	16,523	.....	.....
Staves	228	1,739	206	81	58	.....
Stone	.....	.....	.....	.....	.....	4,600
Miscellaneous	105,395	5,964	14,107	2,719	136	373
Total down freight	165,112	52,346	100,584	63,435	37,726	29,670
Return freight	63,518	17,605	19,942	30,051	28,650	19,780
Total	228,630	69,951	120,526	93,486	66,376	49,450
Estimated value	$6,061,000	$3,422,000	$6,877,000	$9,185,000	$6,820,000	$5,370,000

In addition to the above from Ouachita River, entering Red River at mouth of Black River, 95,860 tons, the value of which is estimated at $3,430,000.

Receipts and shipments of bales of cotton at Shreveport, La.

	1893-'94.	1892-'93.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
RECEIPTS.						
By rail	30,033	25,277	44,256	39,890	25,476	30,331
By wagon	41,014	31,612	49,644	37,725	40,026	35,450
By river	5,581	4,821	9,189	14,836	8,897	12,368
Warehouse receipts	76,628	61,710	103,089	92,451	74,399	78,149
SHIPMENTS.						
By Texas and Pacific Railway	25,019	26,904	36,645	23,311	23,650	20,582
By Vicksburg, Shreveport and Pacific Railroad	10,546	10,384	23,251	15,564	20,813	24,029
By Houston and Shreveport Railroad	13,429	3,114	5,353	13,860	12,529	494
By St. Louis Southwestern Railway	17,817	7,818	24,187	15,039	8,820	24,125
By river to New Orleans	9,246	14,751	10,567	19,218	8,412	8,956
Total	76,057	62,971	100,003	86,992	74,264	78,186

The water route from Shreveport, La., to Jefferson, Tex., through the lakes and Cypress Bayou, was reported navigable for seven months during the fiscal year, from early part of November until June. The *Rosa Bland* was the only steamer reported as employed in the trade. The commerce reported was as follows:

Articles.	1893-'94.	1892-'93.	1891-'92.	1890-'91.	1889-'90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	320	1,115	467	625	200
Cotton seed	65	105	60	200	25
Hides and skins	2	6	75	.....	.....
Live stock	2	4	14	.....	.....
Lumber	.....	44	.....	.....	.....
Saw logs	49,200	62,100	60,075	82,400	(*)
Shingles	.....	2,000	.....	.....	.....
Miscellaneous	175	45	900	1,825	.....
Total down freight	49,764	65,419	61,591	85,050	225
Return freight	605	732	272	700	3,300
Total	50,369	66,151	61,863	85,750	3,525
Estimated value	$336,000	$535,000	$344,000	$748,000	$394,325

(*) Not reported.

npeting routes of transportation for the trade of Red River Valley below rk., are as follows: The river is crossed by the St. Louis, Iron Mountain and Railway at Fulton, Ark., by the St. Louis Southwestern Railway (Cotton Belt t Garland, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at rt, La., and a branch of the Cotton Belt system from Lewisville, Ark., 8 miles iarland, runs parallel to the river to Shreveport. The Texas and Pacific runs nearly parallel to the river and touches at Alexandria, Boyce, Shreve- l other points on the main river, and at Jefferson, Tex., on Cypress Bayou; nects at Texarkana, Ark., with the Cotton Belt and St. Louis, Iron Mountain thern. Morgan's Louisiana and Texas Railroad, a branch of the Southern runs from Alexandria to the main line. Shreveport is the eastern terminus Houston and Shreveport Railroad. The Houston, Central Arkansas and n Railroad, a branch of the Missouri Pacific system, crosses the river about above Alexandria. The Kansas City, Watkins and Gulf Railway runs from harles, La., on the Southern Pacific, to Alexandria; and another line is pro- hat will cross at Alexandria. Jefferson, Tex., at the head of navigation of Bayou, has transportation by the Missouri, Kansas and Texas Railway, in a to the Texas and Pacific Railway mentioned above. The Kansas City, as and New Orleans Railroad is projected to run about 300 miles from the i State line through Central Arkansas to the Louisiana State line. The Tex- and Shreveport Railroad is built from Texarkana to Lynn, Ark., about 6 om the mouth of Sulphur River. The Texarkana and Fort Smith Railway, ed from Kansas City, Mo., to Sabine Pass, Tex., will touch Red River at port, La. An extension of the Sherman, Shreveport and Southern Railway is ed to run from Jefferson to Shreveport, about 50 miles, or from Jefferson to n, Tex., about 30 miles.

REPORT OF ASSISTANT ENGINEER H. M. MARSHALL.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 18, 1894.

TAIN: I have the honor to submit the following report on Red River survey: ut the middle of August last two small flatboats, 16 by 65 feet, were built and ted, one at Fulton, Ark., and the other at Shreveport, La. Although the lum- as rough and unseasoned the boats were light draft by reason of the small isions of timbers used and because tents were substituted in place of cabins using. The boats were patterned like those used on Missouri River survey, t that the cook houses were built of light lumber. They afford ample and able summer quarters, and if they could be broken up at the end of survey, to the expense of towing to some distant depot, they would be entirely satis- y.

party under Assistant Engineer T. C. Thomas, consisting of a topographer, a r, a cook, and 9 laborers, started from Fulton August 21, and on the same like party under Assistant Engineer G. C. Haydon began work at Coushatta, g floated down from Shreveport.

work comprised the locating of bank lines, setting low-water gauges to read ater-surface elevation expressed in meters above Cairo datum, sounding cross ns, taking discharge and sediment observations, making borings in the river at shoal crossings, and ascertaining the water-surface slope at those places. anks were located by transit and stadia line connecting with permanent monu- s at frequent intervals. Gauges were set by duplicate lines of wye levels from ent bench marks. Soundings were made from a skiff drawn across the river eans of a small steel-wire rope stretched between stakes half a meter high set e water's edge on both banks. The rope was tagged at regular intervals and ps of the stakes were "shot in" by the topographer. Discharge was measured a current meter at mid depth at several positions in the cross sections. Sedi- was collected at the surface, mid depth, and bottom at quarter intervals across n, by means of a bottle with a controllable valve stopper. Borings were made lepth of 6 to 7 meters by driving down well-pipe, 1¼ inches inside diameter, a small pile-driver mounted on a flatboat. When driving on land, if the pipe ne filled or ceased to pick up material it was pulled up and another inserted in me hole; out in the river the drive was continuous. Pipes containing mate- ere marked for identification by numbers cut with steel dies, caps were ed over the ends, and they were shipped to the office for future examination. ce slope was taken by levels on the tops of pegs driven simultaneously.

ept during a sharp rise in October, the river stage was quite favorable. Some gauges set above Shreveport during the rise proved to be of insufficient

length, and were left high and dry before low water was reached. It was inten to secure morning and evening readings covering the period of extreme low wa and though the gauges had all been set and reports received from nearly all observ yet many failed to report at the critical time. Some were precluded by the w being below their gauge, as stated above, though a few of the observers did mea down and report the stage below the gauge. Others reported the first low s during September and neglected to report during November. The latter was erally slightly below the former.

In the table 1, which follows, all elevations of the low water of 1893 which not derived from actual gauge readings are marked "interpolated." The fig given were derived by assigning at low water the same slope that obtained bet adjacent gauges at some other low stage. Usually the margin for error was than the allowable discrepancy in the levels for setting a gauge, and in no case at all probable the elevation given errs by a decimeter. The first part of the is made up from gauge readings and elevations from level notes of former sur Many of these elevations do not refer to extreme low water; in fact, only a fe but the relative stage can be approximated from the synchronous water surfa one of the permanent gauge stations—Fulton, Shreveport, or Alexandria. G relation, however, seems even more uncertain at low than at high water, and, in the dates suggest that the stage can be best predicted from the downstream g

Table 2 gives the slope over the "Alexandria Falls" at low stages, and sho decrease of slope in later years. In this connection it is well to note the steep over the reach below Alexandria and the small slope above the falls, especially Lower Flagland to Meyer's place, and to recall the fact that between the points there is always "good water" at all stages. The soundings have not y been put into shape for plotting, but enough has been done to bear out the asse that the depth varies inversely with the slope. The borings, almost without e tion, show that the shoals are made up of sand deposit or sand and small gravel other words, the river makes the shoals, and in some instances removes them out any apparent cause. A case in point is the one near Grimes Bluff, 681.5 meters below Fulton. At time of survey, November, 1890, there was a large g bar above water along the left shore at the head of the bend, where the river t to the right. The crossing at the head of the bar was short, with the channel b close around the point. The depth on the shoal was 1.3 meters, with the water face 17.3 meters above Cairo datum. In November, 1893, the bar had been en ti swept away, and the channel depth was 3.4 meters over the site, with the w surface 18.7 meters Cairo datum. There had been no material change in bank for a distance of 5 kilometers above or below, yet where formerly had been a ra was later a calm pool. High-water profile shows a flatter slope in this vicini 1894.

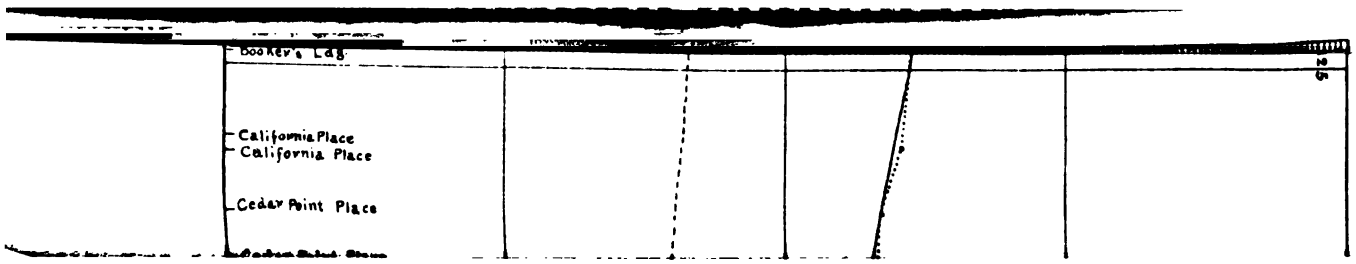
Table 3 gives the discharge taken during progress of the survey. The noticeable feature is the great difference in discharge at the low period in Septe and in November, although the water surface was nearly identical. The disch during the first low water, measured at mouth of Cane River, exceeded by hal discharge during the second low water, measured near Coushatta. The interme bayous, Wincey, Pierre, and Saline, are too small at this stage to have any effect hence either the bars had risen so that the water surface from gauge to g remained unchanged, or the flow through the pools was checked by a flattened and the velocity of approach at the shoals diminished. Under the latter sup tion, if the loss in velocity of approach exceeded the velocity due to the locale there would be a raising of the water surface accompanying the lesser disch This would account for the small variations at the different gauges.

Table 4 gives the results of sediment observations. An attempt was made to relate the amount of sediment by plotting the per cent as ordinates, to stage a low water as abscissæ, and in like manner to the change in stage during the pre twenty-four hours. The former failed to reveal any relation whatever. The l suggests that the sediment is least when the river is stationary and increases wit rate of change whether rise or fall. The observations, however, were too few and to asunder to afford more than a hint. The quantity of sediment borne in suspe by a river seems of small account, for it is brought in by drainage from the and if any deposit is made while the rise is "checking up" it is removed by the for the one is generally a nearly exact reflex of the other. This does not refer t material moved along on the bottom.

Table5 gives the maximum height of the first rise of 1894 at gauge stations repo and a comparison with high water of 1892.

Table 6 gives a like comparison for the second rise. They are principally sig cant in showing how little is to be learned from gauge readings unaccompanie discharge measurements, though they may be useful in future for reference.

Profiles showing high and low water have been prepared and are submitted. sheet showing Red River near Tones Bayou, from U. S. Engineer surveys, 1872


Booker's Lag
California Place
California Place
Cedar Point Place

1893, with a plate showing cross sections, is also appended. The original maps were reduced to the same scale and a tracing made of one of them; then the bank lines at the head of the upper bend were superposed and the maps oriented by the meridian. Every attempt to put the maps together in any way other than orienting by the meridian showed a constantly increasing divergence in bank lines. To connect the datum planes of levels and cross sections elevations of about fifteen points common to the two surveys were selected independently by three persons, and the mean of the differences taken as the correction to Cairo datum. The number of points to choose from was quite large, and the points selected by each observer were rarely the same, yet the mean differed only 2 decimeters from the extreme set.

At the end of the fiscal year there will remain to be done to complete the record of the survey 2 map sheets and tracings of the original field work, together with title and index sheets; 30 map sheets and tracings of the field work of this season, 34 being already finished; reduction of soundings and sections made at the latter period, and also of some early local surveys near Tones Bayou, Alexandria, and the mouth of Red River; plotting and measuring cross sections, save some in the neighborhood of Cottonwood Bayou and those through Little River; completing examination of borings now in progress. An attempt will be made to ascertain graphically the controlling elements in a river bed by plotting area, width, depth, curvature, and slope, two and two as coordinates.

The personnel of the parties has in the main continued the same, and when a reduction of force became necessary, the law of evolution was given full effect.

Very respectfully, your obedient servant,

H. M. MARSHALL,
Assistant Engineer.

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana.*

LOWEST ASCERTAINED WATER OF 1871.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Water-surface elevation, Cairo datum.		
				Fulton.	Shreveport.	Alexandria.
	Kilos.	*Meters.*		*Meters.*	*Meters.*	*Meters.*
Spring Bank, Ark	174.2	69.72	Nov. 7	.....	56.75	.....
Jefferson, Tex	.....	59.33	Nov. 14	.....	55.85	.....
Spring Bank, Ark	.....	69.35	Nov. 20	.....	55.78	.....
O'Kouk Slough, La	197.8	68.76	Nov. 20	.....	.....	.....
Jackson Landing, Tex	.....	59.26	Nov. 20	.....	.....	.....
Curtis Place, La	319.9	55.66	Nov. 20	.....	.....	.....
Spring Bank, Ark	.....	68.53	Dec. 7	.....	55.08	.....
Kouns Canal, La	208.1	66.95	Dec. 7	.....	.....	.....
Mouth "The Ditch," Tex	.....	59.10	Dec. 7	.....	.....	.....
Spring Bank, Ark	.....	67.89	Dec. 27	.....	53.20	21.68
Fuller Inlet, La	222.8	64.89	Dec. 27	.....	.....	.....
Port Caddo, Tex	.....	58.17	Dec. 27	.....	.....	.....
Curtis Place, La	*333.8	54.56	(†)	.....	.....	.....
Scopini Place, La	339.7	52.55				
Above Lattier Cut-off, La	321.4	55.22	(†)	.....	.....	.....
Below Lattier Cut-off, La	327.2	54.58				
Shreveport, La	303.2	50.83	Reputed L. W	.....	.....	.....
Curtis Place, La	.....	49.90	....do	.....	.....	.....
Alexandria, La	640.9	19.66	....do	.....	.....	.....

* Measured through Lattier Cut-off (1882), Louisiana. † Both same day; date unknown.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*— Continued.

LOWEST ASCERTAINED WATER OF 1872.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Water-surface elevation, Cairo datum.		
				Fulton.	Shreveport.	Alexandria.
	Kilos.	*Meters.*		*Meters.*	*Meters.*	*Meters.*
Spring Bank, Ark	174.2	67.80	Jan. 4	.....	53.66	21.15
Gilmer Landing, La	230.1	64.21	Jan. 4	.....	.....	.....
Carolina Bluffs, La	248.9	60.28	Jan. 4	.....	.....	.....
Anna Glade, Tex	.....	58.24	Jan. 4	.....	.....	.....
Spring Bank, Ark	.....	68.90	Jan. 16	.....	53.43	21.58
East Egypt Place, La	236.6	62.82	Jan. 16	.....	.....	.....
Carolina Bluffs, La	.....	60.82	Jan. 16	.....	.....	.....
Head Ferry Lake, Tex	.....	58.50	Jan. 16	.....	.....	.....
Spring Bank, Ark	.....	68.40	Feb. 25	.....	54.96	24.17
Carolina Bluffs, La	.....	60.94	Feb. 25	.....	.....	.....
Curtis Place, La	319.9	54.64	Mar. 4	.....	54.71	25.05
Above Lattier Cut-off, La	321.4	54.28	Mar. 5	.....	54.60	24.93
Do	.....	54.06	Mar. 7	.....	54.39	24.51
Below Lattier Cut-off, La	327.2	53.49	Mar. 7	.....	.....	.....
Foot Ferry Lake, La	.....	58.25	Mar. 8	.....	54.29	24.32
Henderson Mill, La	.....	56.02	Mar. 8	.....	.....	.....
Tones Bayou, La	*{332.5 / 338.4}	52.40	Mar. 8	.....	.....	.....
Mouth Cottonwood Bayou, La	.....	57.94	Mar. 9	.....	54.25	24.23
Scopini Place, La	*{333.8 / 339.7}	52.27	Mar. 9	.....	.....	.....
Albany Point, La	.....	57.84	Mar. 12	.....	54.07	23.81
Scopini Place, La	.....	52.11	Mar. 12	.....	.....	.....
Mouth Tones Bayou, La	.....	51.51	Mar. 12	.....	.....	.....
Cuba Place, La	287.9	56.95	Mar. 13	.....	53.97	23.63
Cuba Place (Twelve Mile Bayou) La	.....	56.71	Mar. 14	.....	53.91	23.54
Scopini Place, La	.....	52.01	Mar. 14	.....	.....	.....
Twelve Mile Bayou (near mouth), La	.....	54.59	Mar. 15	.....	53.89	23.33
Scopini Place, La	.....	51.99	Mar. 15	.....	.....	.....
Shreveport, La	303.2	49.43	Reputed L. W	.....	.....	.....
Alexandria, La	640.9	18.87	Dec. 7–12	.....	.....	.....

* Measured through Lattier Cut-off (1882), Louisiana.

LOW-WATER MARKS OF 1873 FROM GAUGE RECORDS.

Shreveport, La	303.2	50.30	Sep. 28	.....	.....	19.56
Alexandria, La	640.9	19.51	Oct. 1–11	.....	{50.45 / 51.03}	.....

LOWEST ASCERTAINED WATER OF 1874.

Jefferson, Tex	.....	57.07	Reputed L. W	.....	.....	.....
Port Caddo, Tex	.....	57.02	....do	.....	.....	.....
Swanson Landing, Tex	.....	57.02	....do	.....	.....	.....
Mooringsport, La	.....	57.02	....do	.....	.....	.....
Albany Point, La	.....	55.38	....do	.....	.....	.....
Fulton, Ark	0.0	73.92	....do	.....	.....	.....
Carolina Bluffs, La	248.9	59.68	....do	.....	.....	.....
Shreveport, La	303.2	49.46	Sept. 6, 7	.....	.....	18.92
Alexandria, La	640.9	18.86	Sept. 23	.....	50.25	.....

LOW-WATER MARKS OF 1875 FROM GAUGE RECORDS.

Jefferson, Tex	.....	56.73	Nov. 2–8	75.81	{51.66 / 51.32}	19.25 / 19.22
Fulton, Ark	0.0	75.75	Nov. 23, 24	.....	.....	.....
Shreveport, La	303.2	51.10	Nov. 22, 23	.....	.....	.....
Alexandria, La	640.9	18.99	Nov. 22, 23	.....	.....	.....

LOW-WATER MARKS OF 1876 FROM GAUGE RECORDS.

Fulton, Ark	0.0	76	Oct. 20	.....	51.24	19.28
Shreveport, La	303.2	50.78	Nov. 13	76.06	.....	19.12
Tones Bayou, La	332.6	49.91	Nov. 12	.....	.....	.....
Alexandria, La	640.9	19.08	Nov. 16–24	{78.13 / 77.40}	50.87 / 51.07	.....

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1877 FROM GAUGE RECORDS.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Water-surface elevation, Cairo datum.		
				Fulton.	Shreveport.	Alexandria.
	Kilos.	*Meters.*		*Meters.*	*Meters.*	*Meters.*
Fulton, Ark	0.0	75.75	Sept. 5, 6	.....	{51.58 51.82	19.04 19.16
Shreveport, La	303.2	50.67	Oct. 15	.....	.....	.....
Tones Bayou, La	332.6	49.76	Sept. 2	.....	50.89	18.92
Alexandria, La	640.9	18.87	Oct. 14, 15	.....	.....	.....

LOW-WATER MARKS OF 1878 FROM GAUGE RECORDS.

Shreveport, La	303.2	50.22	Nov. 21	.....	.....	18.92
Tones Bayou, La	332.6	49.63	Nov. 15–21	.....	.....	.....
Alexandria, La	640.9	18.87	Nov. 24	.....	50.28	.....

LOW-WATER MARKS OF 1879 FROM GAUGE RECORDS.

Shreveport, La	303.2	49.15	Nov. 1–4	.....	.....	.....
Tones Bayou, La	332.6	48.90	Nov. 4	.....	.....	.....
Alexandria, La	640.9	18.72	Nov. 1, 5	.....	.....	.....

LOW-WATER MARKS OF 1880 FROM GAUGE RECORDS.

Shreveport, La	303.2	50.52	Oct. 28, 29	.....	.....	.....
Tones Bayou, La	332.6	50.12	Oct. 25, 26	.....	.....	.....
Alexandria, La	640.9	19.17	Oct. 27–30	.....	.....	.....
Barbre Landing, La	818.5	8.83	Oct. 27	.....	.....	.....

LOW-WATER MARKS OF 1881 FROM GAUGE RECORDS.

Shreveport, La	303.2	48.92	Sept. 26	.....	.....	.....
Alexandria, La	640.9	18.53	Sept. 27–29	.....	.....	.....
Barbre Landing, La	818.5	*7.24	Sept. 27	.....	.....	.....

LOW-WATER MARKS OF 1882 FROM GAUGE RECORDS.

Shreveport, La	303.2	51.59	July 30, 31	.....	.....	{21.43 21.54
Alexandria, La	640.9	20.04	Oct. 8	.....	51.89	.....
Barbre Landing, La	818.5	*10.51	Oct. 8	.....	.....	.....

LOW-WATER MARKS OF 1883 FROM GAUGE RECORDS.

Shreveport, La	303.2	49.36	Oct. 16–18	.....	.....	.....
Alexandria, La	640.9	18.96	Oct. 19–22	.....	.....	.....
Barbre Landing, La	818.5	7.19	Oct. 17	.....	.....	.....

LOW-WATER MARKS OF 1884 FROM GAUGE RECORDS.

Shreveport, La	303.2	49.13	Sept. 24, 25	.....	.....	19.14
Alexandria, La	640.9	19.08	Nov. 3–5	.....	49.98	.....
Barbre Landing, La	818.5	7.86	Sept. 24–30	.....	.....	.....

* Not the lowest.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1885 FROM GAUGE RECORDS.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Water-surface elevation, Cairo datum.		
				Fulton.	Shreveport	Alexandria.
	Kilos.	*Meters.*		*Meters.*	*Meters.*	*Meters.*
Fulton, Ark	0.0	*75.65	Dec. 16	.....	50.63	19.56
Shreveport, La	303.2	49.40	Oct. 24, 25	.....	.....	.....
Coushatta, La	447.8	35.56	Oct. 20–25	.....	.....	.....
Alexandria, La	640.9	19.04	Oct. 23–25	.....	.....	.....
Barbre Landing, La	818.5	7.77	Oct. 30, 31	.....	49.81	19.18

LOW-WATER MARKS OF 1886 FROM GAUGE RECORDS.

Fulton, Ark	0.0	75.62	Sept. 10, 11	.....	.....	.....
Shreveport, La	303.2	48.89	Sept. 12	75.65	.....	.....
Grand Bayou, La	426.5	37.23	Reputed L. W	.....	.....	.....
Coushatta, La	447.8	35.41	Sept. 20	75.71	49.17	19.38
Alexandria, La	640.9	18.99	Sept. 11–13	.....	.....	.....
Barbre Landing, La	818.5	7.83	Sept. 13, 14	.....	.....	.....
Tones Bayou, La	332.6	48.96	Sept. 16	75.98	49.04	19.56
Gravel Point, La	.....	47.61	Sept. 16	.....	.....	.....

LOW-WATER MARKS OF 1887 FROM GAUGE RECORDS.

Fulton, Ark	0.0	74.79	Sept. 7	.....	.....	18.92
Shreveport, La	303.2	48.97	Sept. 8–11	.....	.....	.....
Coushatta, La	447.8	35.56	Sept. 13	.....	.....	.....
Alexandria, La	640.9	18.74	Sept. 14–16	75.77	49.61 / 49.76	.....
Barbre Landing, La	818.5	†7.71	Sept. 14	.....	.....	.....

LOW-WATER MARKS OF 1888 FROM GAUGE RECORDS.

Fulton, Ark	0.0	75.65	Nov. 1, 2	.....	49.40	19.06
Shreveport, La	303.2	49.33	Nov. 4–6	76.10 / 76.38	.....	19.90
Coushatta, La	447.8	36.57	Nov. 8, 9	76.68	49.61	19.19
Alexandria, La	640.9	18.98	Nov. 7	76.44	49.36	.....
Barbre Landing, La	818.5	†8.62	Nov. 7	.....	.....	.....

LOW-WATER MARKS OF 1889 FROM GAUGE RECORDS.

Fulton, Ark	0.0	75.83	Oct. 28–31	.....	51.16	20.59 / 20.32
Shreveport, La	303.2	50.96	Sept. 4, 10	75.89 / 76.90	.....	19.81
Coushatta, La	447.8	36.55	Sept. 11	.....	50.99	.....
Alexandria, La	640.9	19.72	Sept. 14	82.80	51.25	.....
Barbre Landing, La	818.5	8.83	Sept. 12	.....	51.14	19.77

LOW-WATER MARKS OF 1890 FROM GAUGE RECORDS.

Fulton, Ark	0.0	75.94	Aug. 17–20	.....	.....	.....
Garland, Ark	93.2	68.98	Aug. 17, 18	.....	.....	.....
Shreveport, La	303.2	49.09	Aug. 22–24	.....	.....	.....
Coushatta, La	447.8	36.49	Aug. 22–28	.....	.....	.....
Alexandria, La	640.9	19.64	Aug. 26–29	.....	.....	.....
Barbre Landing, La	818.5	8.93	Aug. 24–26	.....	.....	.....

* Gauge set Nov. 8.

† Not the lowest.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1891 FROM GAUGE RECORDS.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Water-surface elevation, Cairo datum.		
				Fulton.	Shreveport.	Alexandria.
	Kilos.	*Meters.*		*Meters.*	*Meters.*	*Meters.*
Fulton, Ark	0.0	75.78	Nov. 19			
Garland, Ark	93.2	68.76	Nov. 20			
Shreveport, La	303.2	48.63	Nov. 14, 16, 20			
Coushatta, La	447.8	35.85	Nov. 8, 13–16			
Alexandria, La	640.9	19.09	Nov. 16–20			
Barbin Landing, La	719.6	13.85	Nov. 16			
Bayou Lenoir, La	745.1	11.72	Nov. 20			
Barbre Landing, La	818.5	7.13	Nov. 20			

LOW-WATER MARKS OF 1892 FROM GAUGE RECORDS.

Fulton, Ark	0.0	76.19	Oct. 14			19.56
Garland, Ark	93.2	68.92	Oct. 14			
Shreveport, La	303.2	48.54	Oct. 13–15			
Coushatta, La	447.8	35.88	Oct. 21–24	77.20 78.05	48.75 49.25	
Alexandria, La	640.9	19.46	Oct. 20–23			
Barbre Landing, La	818.5	7.37	Oct. 25–26			

LOW-WATER MARKS OF 1893 FROM GAUGE RECORDS.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Rate.	Slope per kilometer.
	Kilos.	*Meters.*		*Meters.*
Fulton, Ark	0.0	75.63	Nov. 20	
Kye Smith Landing, Ark	17.1	*73.80		.107
Ferguson Place, Ark	†25.0 33.8	*72.88		.131
Dooley Ferry, Ark	41.5	72.37	Nov. 20	.066
Topp Place, Ark	51.6	*71.55		.081
Finley Place, Ark	55.7	*71.10		.109
Dobson Landing, Ark	65.7	70.73	Nov. 19	.037
Person Landing, Ark	74.9	*70.00		.069
Gregg Place, Ark	81.0	*69.53		.080
Haynes Place, Ark	87.7	69.37	Nov. 19	.027
Garland, Ark	93.2	69.63	Nov. 18–20	.134
Cryer Place, Ark	‡102.4 107.4	68.18	Nov. 22	.049
Magee Place, Ark	115.8	*67.26		.109
Booker Landing, Ark	123.9	*66.52		.091
California Place, Ark	131.5	66.34	Nov. 20	.023
Cedar Point Place, Ark	137.8	*66.07		.043
Lee Store, Ark	145.7	*65.62		.057
Dukes Bend Landing, Ark	153.9	*64.87		.091
Bell Place, Ark	160.6	*64.19		.101
David Sams Place, Ark	168.4	*63.88		.038
Collins Bluff, Ark	173.8	*63.76		.022
Diggs Bluff, Ark	180.1	*63.40		.043
Blanton Bluff, Ark	188.9	63.08	Nov. 19–20	.047
Missionary Place, La	194	*62.94		.027
Boone Bend, La	200.1	62.43	Nov. 20	.083
Kouns Canal, La	208.1	*61.92		.063
Posten Bayou, La	217.2	61.18	Nov. 20	.081
Elmer Slough, La	226.1	60.94	Nov. 20, 21	.027
East Egypt Place, La	231.8	*60.27		.117
Wild Lucia, La	239.2	*59.82		.061
Rush Point, La	248.3	*58.58		.136
Cottonwood Bayou, La	254.6	*57.65		.147
Willow Bend Place, La	261.5	56.57	Nov. 18, 19	.156
Eric Place, La	266.8	*55.19		.260
Gold Point Place, La	272.7	53.78	Nov. 18, 20	.239
Cash Point Place, La	281.6	*53.54		.027
Pandora Bend, La	287.9	*51.54		.317

* Interpolated.
† Measured through Ferguson Cut-off, Arkansas (1892, Dec. 23).
‡ Measured through Crowell Point Cut-off, Arkansas.

TABLE 1.—*Low-water marks on Red River in Arkansas and Louisiana*—Continued.

LOW-WATER MARKS OF 1893 FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.	Slope per kilometer.
	Kilos.	*Meters.*		*Meters.*
Colquitt Place, La	295.9	* 50		.192
Shreveport, La	303.2	48.36	Nov. 20	.224
Nicholson Place, La	312.2	* 47.45		.101
Curtis Place, La	319.2	47.18	Nov. 19	.038
Sunny Point Place, La	325.3	* 46.79		.064
Childers Place, La	331.4	* 46.65		.022
Lotus Landing, La	337.5	* 46.11		.088
Waterloo Cut-off, La	342.5	* 45.66		.090
Young Point Cut-off, La	348.8	45.18	Nov. 19	.076
Pascagoula Store, La	355.2	* 44.70		.075
Knox Point Place, La	361.7	* 44.14		.086
Caspiana Place, La	367.9	43.77	Nov. 18	.060
Campo Bello Place, La	375.2	43.29	Nov. 18, 19	.066
Cross Keys Place, La	382.7	42.46	Nov. 18, 19	.111
Ninock Bayou, La	390.7	41.41	Nov. 19	.131
Swift Chute Bayou, La	395.5	40.78	Nov. 18, 19	.131
Loggy Bayou, La	405.2	39.74	Nov. 17-20	.107
Nelson Place, La	412.2	39.13	Nov. 18, 19	.061
Elder Grove Place, La	420.4	38.40	Nov. 20-23	.089
Pecan Point Place, La	429.1	* 37.58		.094
Willow Point Place, La	436.8	* 37.20		.049
Cottage Home Place, La	441.9	* 36.70		.098
Coushatta, La	448	35.67	Nov. 23	.169
Viva Landing, La	458	* 34.73		.094
Carnes Place, La	464.4	* 34.05		.106
McKnight Place, La	† 472.5 474	* 33.33		.089
Upper Brazil Place, La	480.3	* 32.97		.057
LeCompte Bluffs, La	‡ 488.7 490.1	* 32.54		.051
J. C. Henry Place, La	498.5	* 30.97		.187
Hyam Place, La	§ 507.2 509	* 30.13		.129
Willow, La	516.9	* 29.39		.094
Tessier Landing, La	526.7	28.40	Nov. 18-21	.101
St. Maurice, La	537.6	27.52	Nov. 18-20	.081
O. K. Landing, La	547.3	* 26.17		.139
High Die Place, La	554.3	* 25.11		.151
Bell Landing, La	564.7	* 24.15		.092
St. Andre Bluffs, La	574.6	* 23.50		.066
Colfax, La	585.8	22.45	Nov. 20	.094
M. E. Landing, La	593.5	* 22.02		.056
Fairmount Place, La	601	* 21.28		.099
Lower Flagland Place, La	608.9	20.98	Nov. 18, 19	.038
Belleview Place, La	616.3	* 20.82		.019
China Grove Place, La	626.5	* 20.72		.010
Meyer Place, La	634.4	* 20.10		.078
Alexandria, La	640.9	19.22	Nov. 20	.135
Cut-off Place, La	648.4	18.17	Nov. 20	.140
Hathorn Place, La	657.1	17.91	Nov. 20	.029
Hortensia Place, La	666	* 17.64		.030
Casa Landing, La	673.6	17.36	Nov. 20	.037
Grimes Bluffs, La	681.7	17.05	Nov. 20	.038
Egg Bend, La	690.6	* 16.88		.019
Cassandria, La	699.3	16.65	Nov. 18-20	.026
Dauzat Place, La	705.8	* 15.20		.223
Normand Landing, La	717.1	14.48	Nov. 18	.064
Ware Landing, La	722.3	13.76	Nov. 20	.138
Brouillette Landing, La	729	13.36	Nov. 18	.059
Saline Bayou, La	738	12.40	Nov. 18	.107
Double Eddy, La	742.6	12.09	Nov. 17, 18	.067
Murry Place, La	750.1	11.75	Nov. 17	.045
Old Harris Place, La	760.1	* 10.42		.133
Little Larto Landing, La	765.7	9.38	Nov. 17	.186
Black River, La	774.2	8.08	Nov. 16, 17	.153
Red Light Landing, La	779	8.01	Nov. 17	.014
Moore Shanty, La	784.4	* 7.99		.004
Bayou Cocodrie, La	794	7.97	Nov. 17	.002
Barbre Landing, La	818.5	7.61	Nov. 17, 18	.015

* Interpolated.
† Measured through Lake End Point Cut-off, Louisiana.
‡ Measured through Upper Brazil Place Cut-off, Louisana.
§ Measured through LeVassar Cut-off, Louisiana.

TABLE 1.—*Low-water marks on Cypress Bayou, in Texas and Louisiana.*

LOW-WATER MARKS OF 1893 FROM GAUGE RECORDS.

Locality.	Distance from Jefferson, Tex.	Elevation, Cairo datum.	Date.
	Kilos.	*Meters.*	
Jefferson, Tex	0.0	56.93	Sept. 21–24.
Mouth Cottonwood Bayou, La	73.7	56.64	Sept. 29.
Shreveport, La	105.9	48.36	Oct. 1, 2.

REMARKS.—Gauge set at head of Cottonwood Bayou Oct. 19, and on Oct. 26, when the water read 59.15 C. D., Cottonwood Bayou became dry near its upper end.

TABLE 2.—*Comparison of low-water slope on Red River, in Louisiana, from Upper Falls to Alexandria gauge.*

LOW-WATER SLOPE OF 1874.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.	Date.
	Kilos.	*Meters.*	
Upper Falls (railroad bridge), La	637.7	19.96	Sept. 23.
Lower Falls, La	639.4	19.04	Sept. 23.
Alexandria, La	640.9	18.86	Sept. 23.

LOW-WATER SLOPE OF 1878.

Upper Falls (railroad bridge), La	637.7	20.42	Dec. 16.
Lower Falls, La	639.4	19.80	Dec. 16.
Alexandria, La	640.9	19.66	Dec. 16.

LOW-WATER SLOPE OF 1879.

Upper Falls (railroad bridge), La	637.7	20.23	July 23.
Alexandria, La	640.9	19.27	July 23.

LOW-WATER SLOPE OF 1884.

Upper Falls (railroad bridge), La	637.7	19.81	Nov. 4.
Lower Falls, La	639.4	19.13	Nov. 4.
Alexandria, La	640.9	19.08	Nov. 4.

LOW-WATER SLOPE OF 1886.

Upper Falls (railroad bridge), La	637.7	20.76	Dec 23.
Lower Falls, La	639.4	20.56	Dec. 23.
Alexandria, La	640.9	20.24	Dec. 23.

LOW-WATER SLOPE OF 1893.

Upper Falls (railroad bridge), La	637.7	19.9	Oct. 5.
Lower Falls, La	639.4	19.5	Oct. 5.
Alexandria, La	640.9	19.24	Oct. 5.

TABLE 3.—*Discharge observations in Red River and tributaries (current meter).*

Locality.	Distance from Fulton, Ark.	Date.	Area.	Maximum mid-depth velocities.	Discharge.	Elevation of water surface, Cairo datum.	Stage above low water, 1893.	Change in water surface per hour for the previous 24 hours.	
								Rise.	Fall.
	Kilos.	1893.	*Square meters.*	*Meters.*	*Cubic meters.*	*Meters.*	*Meters.*	*Mms.*	*Mms.*
Kye Smith Place, Ark..	17.1	Aug. 26	338	0.86	244	76.10	2.30	.....	17.91
Dooley Ferry, Ark.....	41.5	Sept. 1	309	.47	126	73.17.	.80	7.50	.....
Garland, Ark.....	93.2	Sept. 15	322	.35	70	69.1	.47	.....	1.29
California Place, Ark...	131.5	Sept. 28	143	.53	49	66.52	.18	.....	2.08
Above Sulphur River, Ark.....	170.4	Oct. 7	746	1.21	689	68.8	4.98	16.25	.....
Above O'Rouk Slough, La	198.1	Oct. 13	582	.78	378	66.9	4.30	.....	10.41
Above Twelve Mile Bayou, La.....	301.1	Oct. 23	133	1.11	113	*49.45	1.09	.....	5.00
Twelve Mile Bayou (tributary), La.....	301.2	Oct. 23	138	.18	18	*49.45	.....	.....	.....
Below Tones Bayou, La.	333.1	Nov. 1	127	1.09	117	47.16	.66	.....	1.66
At Ninock Bayou, La...	390.7	Nov. 11	158	.62	82	41.5	.09	.....	.41
Pecan Point Place. La...	429.3.	Nov. 21	160	.66	75	37.57	.01	.....	.....
Coushatta, La.....	448	Nov. 25	113	.76	79	35.92	.25	1.25	.....
Coushatta (stone line 21), La	448.4	Aug. 24	361	1.47	286	37.05	1.38	.....	.62
Hyam Place, La.....	509	Sept. 9	317	.86	180	30.9	.77	.....	1.25
Above mouth Cane River, La	585.2	Sept. 26	289	.56	122	22.6	.09	.....	.41
Cane River (tributary), La	585.3	Sept. 26	28	.27	5	22.5	.....	.....	.....
Alexandria, La.....	640.9	Oct. 7	247	.70	140	19.59	.37	14.79	.....
Barbin Landing (stone line 61), La.....	721.8	Oct. 21	470	.80	308	15.6	1.80	.....	5.41
Above Black River, La..	773.8	Oct. 30	212	1.13	*190	8.7	.56	.....	3.33
Black River (tributary), La	774.2	Oct. 30	438	.29	98	8.5	.36	.....	.....
Below Black River, La..	774.6	Oct. 30	615	.55	268	8.5	.36	.....	.....

* Gauge at Shreveport, La.

["Above" or "below" means from 0.5 to 1 kilometer.]

Locality.	Distance from Fulton, Ark.	Date.	Elevation water surface, Cairo datum.	Per cent of sediment to weight of water.				Stage above low water, 1893.	Change in the water surface per hour for the previous 24 hours.	
				Surface.	Mid depth.	Bottom.	Mean.		Rise.	Fall.
	Kilos.		*Meters.*					*Meters.*	*Mms.*	*Mms.*
Kye Smith Place, Ark	71.1	Aug. 26, 1893	76.10	0.143	0.152	0.167	0.154	2.30	.....	17.91
Dooley Ferry, Ark	41.5	Sept. 1, 1893	73.17	.028	.061	.057	.049	.80	7.50	.....
Jett Island, Ark	45.4	Jan. 4, 1893	78.97	.050	.070	.070	.063	6.92	10.00	.....
Garland, Ark	93.2	Sept. 16, 1893	69.1	.061	.050	.053	.055	.47	.....	1.29
California Place, Ark	130	Jan. 19, 1893	70.79	.020	.010	.020	.017	4.41	.....	6.25
Do	131.5	Sept. 28, 1893	66.52	.014	.007	.014	.012	.18	.....	2.08
Above Sulphur River, Ark	170.4	Oct. 7, 1893	68.8	.257	.214	.244	.238	4.98	16.25	.....
Do	.....	Jan. 25, 1893	69.43	.010	.005	.010	.008	5.61	.....	4.17
Shreveport, La	303.2	Feb. 23, 1891	56.30	.010	.030	.008	.016	7.94	.....	5.00
Do	.....	Mar. 3, 1891	55.49	.010	.030	.020	.020	7.13	.....	1.91
Do	.....	Feb. 11, 1893	52.72	.010	.020	.030	.020	4.36	.....	3.75
Above Tones Bayou, La	331.4	Apr. 21, 1891	52.85	.020	.040	.....	.030	6.20	2.08	.....
Tones Bayou, La	332.5	Apr. 28, 1891	53.69	.050	.140	.150	.113	7.15	3.75	.....
Below Tones Bayou, La	333.1	Apr. 24, 1891	53.38	.010	.020	.020	.017	6.88	5.83	.....
Do	.....	Nov. 1, 1893	47.16	.043	.043	.043	.043	.66	.....	1.66
Ninock Bayou, La	390.7	Nov. 11, 1893	41.5	.014	.014	.021	.016	.09	.....	.41
Above Loggy Bayou, La	404.7	May 2, 1891	44.83	.050	.120	.110	.093	5.04	4.58	.....
Below Loggy Bayou, La	405.8	May 6, 1891	45.15	.070	.080	.090	.080	5.44	3.33	.....
Pecan Point Place, La	429.3	Nov. 21, 1893	37.57	.014	.014	.014	.014	.01	.....	.....
Coushatta, La	448	Nov. 25, 1893	35.92	.007	.014	.014	.012	.25	1.25	.....
Coushatta (stone line 21), La	448.4	Aug. 24, 1893	37.05	.014	.021	.028	.021	1.38	.....	.62
Above Bayou Wincey, La	455.7	May 14, 1891	40.39	.050	.070	.080	.067	5.38	1.25	.....
Do	455.7	May 22, 1891	39.87	.030	.050	.070	.050	4.86	.....	5.41
Below Bayou Wincey, La	456.4	May 19, 1891	40.21	.040	.070	.010	.040	5.33	.....	3.33
Above head of Cane River, La	518.3	May 28, 1891	32.96	.040	.060	.070	.057	3.71	.....	7.50
Below head of Cane River, La	520.2	May 30, 1891	32.63	.030	.040	.060	.043	3.57	.....	6.66
Do	.....	June 5, 1891	31.83	.030	.040	.040	.037	2.77	.....	3.75
Above mouth of Cane River, La	585.2	June 11, 1891	25.39	.040	.040	.040	.040	3.08	.....	2.91
Do	.....	Sept. 26, 1893	22.60	.014	.028	.039	.027	.09	.....	.41
Above Alexandria, La	639.3	June 20, 1891	22.42	.190	.200	.210	.200	2.98	6.25	.....
Do	.....	July 31, 1891	20.63	.020	.020	.010	.017	1.19	.....	3.83
Do	.....	Aug. 29, 1891	20.88	.040	.040	.040	.040	1.44	.....	3.75
Alexandria, La	640.9	June 17, 1891	21.98	.080	.060	.070	.070	2.76	5.83	.....
Do	.....	June 25, 1891	22.92	.070	.080	.090	.080	3.70	3.75	.....
Do	.....	July 1, 1891	23.09	.050	.060	.050	.053	3.87	.....	.....
Do	.....	July 8, 1891	23.47	.070	.070	.080	.073	4.25	10.41	.....

TABLE 4.—*Sediment in Red River, Fulton, Ark., to head of Atchafalaya River, Louisiana*—Continued.

Locality.	Distance from Fulton, Ark.	Date.	Elevation water surface, Cairo datum.	Per cent of sediment to weight of water.				Stage above low water, 1893.	Change in the water surface per hour for the previous 24 hours.	
				Surface.	Mid depth.	Bottom.	Mean.		Rise.	Fall.
	Kilos.		*Meters.*					*Meters.*	*Mms.*	*Mms.*
Alexandria, La	.....	July 14, 1891	22.42	.040	.070	.060	.057	3.20	.....	11.25
Do	.....	Aug. 8, 1891	20.47	.020	.030	.040	.030	1.25	5.83	.....
Do	.....	Aug. 15, 1891	21.24	.070	.....	.070	.070	2.02	2.08	.....
Do	.....	Aug. 22, 1891	21.43	.110	.110	.090	.103	2.21	.....	.83
Do	.....	Mar. 7, 1893	24.01	.020	.050	.030	.033	4.79	1.87	.....
Do	.....	Oct. 7, 1893	19.59	.002	.002	.007	.004	.37	14.79	.....
Saline Point (stone line 64), La	739.2	Nov. 21, 1891	12.21	.016	.008	.016	.013	.11	2.08	.....
Do	.....	Nov. 25, 1891	13.80	.008	.016	.016	.013	1.48	.....	.....
Lake Latania (stone line 66), La	752.8	Dec. 2, 1891	11.60	.008	.016	.008	.010	.21	.....	5.83
Do	752.8	Dec. 9, 1891	11.91	.008	.013	.015	.012	.51	1.42	.....
Above Black River, La	773.8	Dec. 21, 1891	10.59	.008	.008	.017	.011	2.45	.....	.09
Above Seven Mile Bayou, La	785	Dec. 29, 1891	12.60	.008	.010	.014	.011	4.61	.....	11.25
△ 457, above Bayou Cocodrie, La	789.5	Jan. 6, 1892	13.50	.020	.030	.040	.027	5.52	.....	6.25

TABLE 5.—*Comparison of the high waters of 1893 and 1894 on Red River in Arkansas and Louisiana.*

FIRST RISE OF 1894, FROM GAUGE RECORDS.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.		Date.	Difference.	Remarks.
		H. W. 1892.*	H. W. 1894.			
	Kilos.	*Meters.*	*Meters.*		*Meters.*	
Fulton, Ark	0.0	85.09	84.67	Mar. 24	—0.42	
Kye Smith Landing, Ark	17.1	83.87	83.14	Mar. 24	—.73	
Dooley Ferry, Ark	†32.7 41.5	81.52	81.27	Mar. 24, 25	—.25	
Simms Island, Ark	47.5	80.93	80.54	Mar. 25	—.39	
Finley Place, Ark	57.2	79.74	79.43		—.31	Mud stain on gauge.
Dobson Landing, Ark	65.6	79.09	78.45		—.64	Do.
Person Landing, Ark	74.9	78.29	78		—.20	Do.
Gregg Place, Ark	81.7	77.76	77.74		—.02	
Haynes Place, Ark	87.7	77.65	77.52	Mar. 24	—.13	
Garland, Ark	93.2	76.76	76.80	Mar. 24	+.04	
Cryer Place, Ark	‡102.4 107.4	75.65	75.77	Mar. 25, 26	+.12	
Dukes Bend Landing, Ark	153.9	72.91	72.05		—.86	Mud stain on gauge.
Bell Place, Ark	160.9	72.81	71.72		—1.09	Do.
Diggs Bluff, Ark	180.1	72.26	71.10		—1.16	Do.
Boone Bend, La	200.1	70.93	70.10	Mar. 29	—.83	
Kouns Canal, La	208.1	70.67	69.93	Mar. 29	—.74	
Posten Bayou, La	217.2	70.06	69.54	Mar. 29	—.52	
Elmer Slough, La	226	68.32	68.57	Mar. 28, 29	+.25	
East Egypt Place, La	232	67.46	68.07	Mar. 29	+.61	
Wild Lucia P. O., La	239.2	66.84	67.52	Mar. 29	+.68	Interpolated.
Rush Point, La	248.5	65.70	66.07	Mar. 29	+.37	Do.
Cottonwood Bayou, La	254.6	64.34	64.44	Mar. 28, 29	+.10	
Eric Place, La	266.7	62.94	62.30		—.64	
Gold Point Place, La	272.7	62.57	61.96		—.61	
Colquitt Place, La	295.7	60.75	60.16	Apr. 2	—.59	
Shreveport, La	303.2	60.04	59.67	Apr. 2	—.37	
Childers Place, La	331.4	56.86	56.95		+.09	
Waterloo Cut-off, La	342.5	55.13	55.53	Apr. 1	+.40	
Young Point Cut-off, La	348.8	54.35	54.75	Apr. 1	+.40	
Knox Point, La	361.6	53.26	53.31		+.05	Mud stain on gauge.
Caspiana Place, La	367.9	52.91	52.88	Apr. 1	—.03	
Campo Bello Place, La	375.1	52.45	51.88	Apr. 1	—.57	
Ninock Bayou, La	390.7	51.68	50.60		—1.08	
Swift Chute Bayou, La	395.5	51.53	50.30		—1.23	
Rainbow Bend Place, La	400	51.30	49.71		—1.59	Mud stain on gauge.
Loggy Bayou, La	405.2	50.83	49.05		—1.78	Do.
Nelson Place, La	412.2	50.40	48.43		—1.97	
Elder Grove Place, La	420.4	49.98	47.73	Apr. 6	—2.25	
Pecan Point Place, La	429.1	48.92	47.04		—1.88	
Willow Point Place, La	436.8	48.66	46.34		—2.32	
Coushatta, La	447.8	47.35	45.05	Apr. 7-9	—2.30	
Viva Landing, La	458	46.12	44.15		—1.97	
Tessier Landing, La	§522 526.7	39.91	38.04		—1.87	
St. Maurice, La	537.6	39.06	37.37	Apr. 10	—1.69	
O K Landing, La	547.3	38.35	37.17		—1.18	
Bell Landing, La	561.7	36.70	35.21		—1.49	Mud stain on gauge.
St. Andre Bluffs, La	574.6	36.12	34.35		—1.77	
M. E. Landing, La	593.5	34.61	33.21	Apr. 11, 12	—1.40	
Fairmount Place, La	601	34.01	32.71		—1.30	Do.
Lower Flagland Place, La	608.2	33.47	32.25		—1.22	Do.
Belleview Place, La	616.3	32.74	31.64		—1.10	
Alexandria, La	640.9	31.30	30.40	Apr. 12	—.90	
Cut-off Place, La	648.9	30.72	29.96	Apr. 14	—.76	
Hathorn Place, La	657.1	30.07	29.47		—.60	
Hortensia Place, La	666	29.25	28.55		—.70	
Casa Landing, La	673.6	28.68	28.20	Apr. 12, 13	—.48	
Grimes Bluffs, La	681.7	27.79	27.59	Apr. 13	—.20	
Egg Bend, La	690.6	26.82	26.63		—.19	Mud stain on gauge.
Cassandria, La	699.3	25.82	25.60	Apr. 11-15	—.22	
Ware Landing, La	722.3	23.94	23.92	Apr. 10	—.02	
Brouillette Landing, La	729	23.69	23.34	Apr. 10 and 14	—.35	

* For complete record of the high water of 1892 see Report Chief of Engineers, 1893, pp. 1981–1983.
† Measured through Ferguson Cut-off, Ark. (Dec. 23, 1892).
‡ Measured through Crowell Point Cut-off, Ark.
§ Measured through Lake End, Upper Brazil, and Le Vassar cut-offs, La.

TABLE 5.—*Comparison of the high waters of 1892 and 1894 on Red River in Arkansas and Louisiana*—Continued.

FIRST RISE OF 1894, FROM GAUGE RECORDS—Continued.

Locality.	Distance from Fulton, Ark.	Elevation, Cairo datum.		Date.	Difference.	Remarks.
		H. W. 1892.	H. W. 1894.			
	Kilos.	*Meters.*	*Meters.*		*Meters.*	
Saline Bayou, La	738	23.55	23.12	Apr. 14	—.43	
Little Larto Landing, La	765.7	23.52	20.86	Apr. 20	—2.66	
Black River, La	774.2	23.37	20.35	Apr. 14	—3.02	
Bayou Cocodrie, La	794	23.13	19.59		—3.54	
Barbre Landing, La	818.5	22.45	18.93	Apr. 14	—3.52	

SECOND RISE OF 1894, FROM GAUGE RECORDS.

Fulton, Ark	0.0	85.09	84.05	May 4, 5	—1.04	
Kye Smith Landing, Ark	17.1	83.87	82.21		—1.66	
Dooley Ferry, Ark	*32.7 41.5	81.52	80.09	May 5	—1.43	
Simms Island, Ark	47.5	80.93	79.71	May 6	—1.22	
Finley Place, Ark	57.2	79.74	79.18	May 4, 5	—.56	
Haynes Place, Ark	87.7	77.65	77.40	May 5	—.25	
Garland, Ark	93.2	76.76	76.65	May 5	—.11	
Cryer Place, Ark	†102.4 107.4	75.65	75.65	May 4, 5	—.00	
California Place, Ark	131.5	74.12	73.41	May 5	—.71	
Dukes Bend Landing, Ark	153.9	72.91	71.65		—1.26	
Bell Place, Ark	160.9	72.81	71.45		—1.36	
Collins Bluff, Ark	173.8	72.52	71.22	May 8, 9	—1.30	
Boone Bend, La	200.1	70.93	69.69		—1.24	
Posten Bayou, La	217.2	70.06	68.61	May 7, 8	—1.45	
Elmer Slough, La	226	68.32	68.07	May 9	—.25	
East Egypt Place, La	232	67.46	67.48	May 9	+.02	
Wild Lucia P. O., La	239.2	66.84	66.86	May 9, 10	+.02	
Rush Point, La	248.5	65.70	65.40	May 10	—.30	
Cottonwood Bayou, La	254.6	64.34	63.99	May 10	—.35	
Shreveport, La	303.2	60.04	58.23	May 14, 15	—1.81	
Waterloo Cut-off, La	342.5	55.13	55.10	May 15	—.03	
Young Point Cut-off, La	348.8	54.36	54.40	May 15	+.04	
Caspiana Place, La	367.9	52.91	52.40	May 15	—.51	
Campo Bello Place, La	375.1	52.45	51.34	May 15, 16	—1.11	
Elder Grove Place, La	420.4	49.98	45.52	May 18	—4.46	
Coushatta, La	447.8	47.35	42.65	May 17-19	—4.70	
Alexandria, La	‡636.2 640.9	31.30	28.61	May 21	—2.69	
Grimes Bluffs, La	681.7	27.79	26.47	May 20	—1.32	
Ware Landing, La	722.3	23.94	23.65	May 20	—.29	
Brouillette Landing, La	729	23.69	23.22	May 20-22	—.47	
Saline Bayou, La	738	23.55	22.78		—.77	
Little Larto Landing, La	765.7	23.52	19.80	May 18-23	—3.72	
Barbre Landing, La	818.5	22.45	17.46	May 22, 23	—4.99	

* Measured through Ferguson Cut-off, Ark. (Dec. 23, 1892).
† Measured through Crowell Point Cut-off, Ark.
‡ Measured through Lake End, Upper Brazil, and Le Vassar cut-offs, La.

V 2.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

An examination of Red River above Fulton, Ark., was made in 1884, in compliance with river and harbor act of that year, and the plan recommended for its improvement contemplated removing snags, drift, etc., to secure safer high-water navigation to the mouth of Kiamichi River, Indian Territory, about 138 miles above Fulton. The cost of the work was estimated at $10,000, if granted in a single appropriation. (Report Chief of Engineers, 1885, pp. 1617-1627.) In 1889 an

additional appropriation of $2,000 was asked for, to be applied to going over and completing the work. After the expenditure of this amount, it was recommended that nothing further be done, unless a single appropriation of not less than $10,000 be granted, to allow the systematic clearing of the banks and removal of logs from the channel.

The appropriations have been as follows:

By act of—	
August 5, 1886	$7,000
August 11, 1888	3,000
September 19, 1890	2,000
July 13, 1892	3,500
Total	15,500

In the fiscal year 1887 the hand-propelled snag boat *Harry Breck*, fitted with steam capstan, was built at Fulton at a cost of $4,000 for use on this improvement. During the periods of low water in 1887 and 1888 this boat was employed in removing obstructions until the funds were exhausted, after which, in December, 1888, it was transferred for temporary use in Red River below Fulton. In February, 1891, the snag boat was sold to the work of improving Red River, Louisiana and Arkansas, for $1,500, and the proceeds of the sale were applied to removal of obstructions above Fulton, in connection with the appropriation of September 19, 1890. In January and February, 1891, the snag boats *Howell* and *Breck* were employed in going over the work, and operations of the former extended upstream to within 30 miles of the upper limit, as far as the boat was able to go on the stage of water, and a fair steamboat channel was cleared for navigation at high stages of water, practically completing the project for this improvement.

Under the act of 1892 the United States snag boat *C. W. Howell* worked over the river January 1 to March 11, 1893, operations extending from Fulton to the mouth of Kiamichi. The river was found to have scoured and improved considerably since the work done in 1891, and the *Howell* reached the upper limit at stages near extreme low water without much difficulty. Owing to the constant scour, the majority of the obstructions encountered were removed with greater ease than when the previous work was done. The limited appropriation rendered any attempt to remove all obstructions impracticable, and operations were confined to clearing a safe channel for passage of the *Howell*. Judging from previous work, the channel should have widened and scoured considerably, giving better and safer navigation at all stages, but since operations ceased there has been no means of inspecting the river at low water to determine what changes have occurred and the amount of drift contributed from the extensive woodlands above.

No work was done during the fiscal year ending June 30, 1894, as the balance available was not sufficient to resume operations.

The commerce and navigation of Red River above Fulton are as yet so limited that it is not believed that any extensive improvement is required at present, and the recommendation made in my reports of 1891, 1892, and 1893 still remains applicable, viz:

This part of the river is navigable for the smallest boats, and during high stages only. Lanesport, Ark., near the Indian Territory line, 74 miles above Fulton, usually is considered the upper limit of navigation, but boats make occasional trips to Kiamichi on the highest stages of river. Below the Kiamichi, Red River has no tributary of consequence except Little River, which enters the main stream 2 miles above Fulton. The oscillations are so rapid that frequently boats can run in one direction only on a single rise, and have to regulate their trips by the quantity and duration of rainfall in the upper river country.

The banks are covered with trees constantly caving or sliding into the river, and if the removal of obstructions from the channel were continued and the timber cleared from the banks to stop further accumulations, navigation would be safer and there would be less drift to contend with in the river below Fulton, but it is doubtful if the boating period would be lengthened or the upper limit extended.

I recommend one of two courses in regard to this part of Red River; either that no further work be done in it until there shall be a pressing demand for a considerable improvement from Fulton upward, including Little River, both to gain a better and longer period of navigation and to help drain the adjacent lands; or else that a liberal amount, say not less than $10,000, shall be given in a single appropriation to allow the systematic clearing of the banks and removal of logs from the channel way to permit the bottom to scour. In no other way can the money be expended economically or any appreciable results obtained. The cost of organization and administration will be about the same for a small appropriation as for a large one, and the cost of getting the plant to the scene of operations and returning it to the fleet or other work will reach together nearly $1,000. The estimate is submitted with the idea of sending all the snag-boats in Red River to work together under one management just as soon as the spring floods begin to subside, the snag boats to be employed on the wrack heaps and heavy obstructions, and the chopping parties to clear the banks, so that all loose stuff shall go out on the first and succeeding rises. This will allow about six weeks to two months' work of the snag boats, the lightest draft boat being kept perhaps somewhat longer, and the boat with the chopping party continuing on downstream on bank work and small jams. About $1,000 should be held in reserve to send a snag boat over the whole the following season to dislodge heavy drift and pick up channel snags.

Money statement.

July 1, 1893, balance unexpended	$292.65
June 30, 1894, amount expended during fiscal year	2.29
July 1, 1894, balance available	290.36
Amount that can be profitably expended in fiscal year ending June 30, 1896. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

COMMERCIAL STATISTICS.

During the fiscal year Red River above Fulton, Ark., was reported navigable from July to August and from November to May. Denison, Tex., is said to be the head of high-water navigation.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
					Light.	Loaded.		
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
C. R. Cummings	41.81	62	14.6	3	1 0	2 4	Arthur, Tex., and Blue River.	38
							Arthur, Tex., and Kiamichi River.	5
Gamma	44.32	84	18.4	4.3	2 6	3 6	Monroe, La., and Little River, Ark.	9
Florence	18.49				3 0		Index, Tex., and Shreveport, La.	34

Summary of commerce reported.

Articles.	Tons.	Articles.	Tons.
Cotton	40	Staves	600
Cotton seed	1,500	Miscellaneous	110
Hides and skins	1		
Live stock	475	Total freights	38,826
Lumber	100	Estimated value	$133,000
Saw logs	36,000		

The river, from the mouth of Kiamichi, the upper limit of the improvement, to Fulton, is paralleled by a branch of the Texas and Pacific Railroad from Texarkana to Paris, Tex., connecting at the latter place with the St. Louis and San Francisco Railway, a branch of the Atchison, Topeka and Santa Fe system, which crosses Red River at Arthur, Tex. The Texarkana and Fort Smith Railway crosses the river about 10 miles north of Texarkana, and the St. Louis, Iron Mountain and Southern Railway crosses at Fulton, Ark.

V 3.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Ouachita (the Indian name for black) River has its source in Polk County, Ark., and following an irregular course flows in a general southeasterly direction through Arkansas and Louisiana until joined by Tensas and Little rivers at Trinity, La. Below this junction it is known as Black River, and flows in a southerly direction, entering Red River 35 miles above its mouth. The entire length of Ouachita River is about 500 miles and that of Black River is 47 miles.

The report on the Mississippi Delta Survey (Humphreys and Abbot, edition of 1876, p. 26), quoting from Darby, says:

Few rivers differ more in the quantity of water at different seasons than the Ouachita. Flowing from a hilly or mountainous tract, more constancy might be expected in the column of water; but though the places drained by the Little Missouri and Fourche au Cado are not deficient in springs, yet the extensive region toward the sources of Ouachita has little water except what is supplied by rains in winter and spring. When the parching heat of summer has dried the country above the mouth of the Little Missouri the Ouachita becomes very low as far south as the head of Black River.

Under river and harbor act of 1870 an examination of Ouachita River was made and a project submitted for temporary improvement from Arkadelphia, Ark., to its mouth by the removal of snags and dredging the worst bars (Report Chief of Engineers, 1871, pp. 334–346), and the work was commenced in 1871. A survey from Camden, Ark., to Trinity, La., was ordered by act of 1871, the report on which recommended improvement by locks and dams (Report Chief of Engineers, 1872, pp. 367–374). This plan of improvement contemplated building five locks and dams (timber), located at Catahoula Shoals, Taylors Shoals, and Rock Row, Louisiana, and at Jacks Island and Buffalo Flats, Arkansas. The size of the locks was 49 by 250 feet, with an average lift of 14 feet, and the estimated cost of the work was $1,163,083.75. In January, 1873, contracts were let for furnishing the timber for foundations of the locks at Rock Row, Jacks Island, and Buffalo Flats. In February, 1873, the maps and notes of the survey were reviewed by a board, and it was deemed necessary to make a resurvey of the river to determine definitely certain questionable points connected with the contemplated

improvement. The resurvey was ordered by the Department with a view to revising the project, and was completed by Captain (now Lieut. Col.) Benyaurd in 1874.

Captain Benyaurd's report upon the resurvey is given in full in the Report of the Chief of Engineers for 1874, Part I, pp. 352–364, from which the following extracts are taken, viz:

The distance from Camden to Trinity is 294.07 miles, with a total fall at low water of 65.4 feet, this being an average of 0.22 foot per mile. This fall is divided between two certain points, as follows:

Points.	Distance in miles.	Fall in feet.	Fall per mile.
			Feet.
Camden to Eldorado Landing	43.71	17.3	0.396
Eldorado Landing to Jacks Island	32.12	9	.280
Jacks Island to Ouachita City*	64.67	9.1	.140
Ouachita City to Columbia	85.81	23.4	.273
Columbia to Trinity	67.76	6.6	.097
	294.07	65.4	.222

* Includes overflow region.

The river is a succession of pools and shoals. An inspection of the maps shows the existence of 65 of the latter, with a total length of about 40 miles, or nearly one-seventh of the entire length of that portion of the river under consideration, and the least depth on many of them is less than 1 foot.

The difference between extreme high and low water at Camden is 39.25 feet; at Trinity it is 53.4 feet. The low summer discharge at Camden is 353 cubic feet per second.

* * * * * * *

After an examination of the subject, I am satisfied that the plan of improvement by locks and dams is the only one that will give permanent and uninterrupted navigation to Camden, Ark., throughout the entire year. All others, whether by wing dams or dredging, would be only temporary in their character. The project, as approved by the Department, requires revision on account of faulty location of dams, etc., and not being adapted to any but the very smallest boats navigating the Ouachita.

After discussing the classes and sizes of boats then navigating the Ouachita, and showing that none but the smallest boats could use the locks proposed, he gives arrangements for locks large enough to accommodate the larger-sized boats to Camden; for locks large enough to accommodate that class to Monroe, with smaller locks above, and for locks sufficient only for stern-wheel boats. The estimates of cost of construction ranged from $2,626,252 to $2,995,566 for timber locks, and from $4,952,976 to $6,079,233 for masonry locks.

Continuing, he says:

It must be remembered that in making these estimates the cost is greatly increased on account of the character of the country in which the improvement is contemplated, as it offers no facilities for securing skilled labor or material of any kind except timber, and requiring every other material that would be used in construction of the works to be brought from a distance and before navigation closed, thus greatly enhancing the cost, in addition to which any number of claims would be brought against the Government for damages supposed to be done to the lands on account of the pools created by the dams.

* * * * * * *

In considering the above plans of improvement, we must from the beginning take into account the floods of the river and the damage to which the works will be subjected by placing them in a channel so contracted as that of the Upper Ouachita, and upon soil so unstable as the river bed.

So far as the permanent improvement of the river is concerned, that by locks and dams is the only one that will give continuous and uninterrupted navigation throughout the entire year to Camden, Ark.; and of the three plans mentioned above, the third, though it shuts out the larger class of boats, is the best, considering the nature of the river, the commerce, and the wants of the country which the contemplated *improvement* will benefit.

i follows a statement of the commerce of the river, with the rea-
r a probable decrease of business on account of railroad compe-
and the report continues as follows:

l be seen from the above that the greatest amount is shipped during the last
of winter and the first of spring. This always accords with the best stage
', though there is generally in December a stage sufficient for navigation;
main bulk of the cotton is not brought out to be shipped until later. Any
of locks and dams during this season would be superfluous; in fact, such an
ment would be more of an obstruction in a river like the Ouachita at that
t would only be during the late summer and early fall months that the
ment would be of particular service. During these months no crops are
oved and no particular trade is being carried on that would induce boats to
n if there was sufficient water naturally at these seasons. One, or at the
two, of the small Ouachita River packets would be sufficient for the trade.
rovement, if made, will cost, according to the lowest estimate above pre-
2,626,252, and this involves also the improvement of the mouth of Red River,
h no estimate can be presented. Without the latter improvement the locks
main idle at the time they were intended for use.
me might be said of the temporary means of improvement by dredging, for
ome of the bars and shoal places below Monroe are composed of gravel of
t size to resist the force of the current, and reasonably good results might
ned by dredging, yet if we attempted to maintain a channel deep enough
arge boats the same obstruction would deter such boats from taking advan-
the improvement. No doubt such improvement will tend to develop the
s of the country and encourage and increase the cultivation of land now lying
cheapening transportation in competition with the railroad line that will
uilt in that country; still, I fail to see the necessity at the present time of
an improvement of the river by locks and dams, and in view of all the cir-
ces I would respectfully recommend for the present the abandonment of the
or lock-and-dam navigation of the Ouachita.

he reasons given in the foregoing report it was considered inex-
to go on with the construction of locks and dams, and the project
andoned, the contracts for timber were annulled, the material on
as sold at auction and the proceeds turned into the Treasury,
on the recommendation of the officer in charge, the available
ere applied to construction and operation of a snag boat.
roject under which work below Camden, Ark., has been carried
e 1874 contemplates the removal of snags, logs, wrecks, leaning
etc., obstructing navigation and the improvement of shoal

The appropriations have been as follows:

Date of act.	Locality.	Amount
Mar. 3, 1871	Between Arkadelphia, Ark., and Louisiana State line	$25,0
Do	Between Arkansas State line and Trinity, La	26,0
June 10, 1872	Between Arkadelphia, Ark., and Louisiana State line	60,0
Do	Between Arkansas State line and Trinity, La	40,0
Mar. 3, 1873	....do	60,0
Aug. 14, 1876	Between Camden, Ark., and Trinity, La	12,0
June 18, 1878	....do	10,0
Mar. 3, 1879	....do	10,0
June 14, 1880	....do	8,0
Mar. 3, 1881	....do	12,0
Aug. 2, 1882	....do	12,0
July 5, 1884	Between Camden, Ark., and mouth of Black River, Louisiana	15,0
Aug. 5, 1886	....do	17,5
Aug. 11, 1888	....do	20,0
Sept. 19, 1890	....do	15,0
July 13, 1892	....do	40,0
	Total	382,5

The amount expended to June 30, 1893 (including outstanding liab ities of $14.92), was $351,938.94, of which $238,351.07 had been applied operations under the project of 1874. The iron-hull snag boat *O. Wagner* was purchased for this work in 1875, and repaired with a n steel bottom in 1886. Under provision of the act of 1888 the sm wooden steamer *Hooker* was purchased that year and fitted up for lig snagging. From 1875 to the end of the fiscal year 1893 operations we carried on whenever funds were available and conditions favorable work. The work consisted chiefly of the removal of snags, logs, wrec and tree slides from the channel, and cutting leaning timber, though increase of depth was gained at some of the shoals by the constructi of wing dams of stone or brush.

Operations during the fiscal year ending June 30, 1894, were cont ued as follows:

The water having fallen to a stage favorable for work in Up Ouachita, the United States snag boat *O. G. Wagner*, A. P. Boardm master, left Alexandria, La., July 23, 1893, towing a quarter boat use in Bayou Bartholomew. The run from Alexandria to Bayou B tholomew was made July 23–31, and snagging operations in Ouach River were commenced the latter date, working upstream. On rea ing Jacks Island Shoals, 75¾ miles below Camden, August 3, it deemed inadvisable for the boat to proceed farther upstream on a f ing river. Between the latter date and October 17 the river was work over thoroughly from Jacks Island to Catahoula Shoals, a distance 198 miles. Heavy and effective work was done, and the sweep ch was used repeatedly at all bad places. Twenty-four tree slides w removed from the channel, several of which extended entirely acr the river. The wreck of the steamer *Idaho*, sunk in 1869 near Ne Landing, about 25 miles below Columbia, was broken up with explosi and dragged out of the river. This wreck, located in a bend, wa serious obstruction to navigation at low stages. October 17 the *W ner* pulled over Catahoula Shoals, commenced work the following on Bayou Louis Reach below, where operations were continued u October 25, when, the funds available for snagging operations be practically exhausted, the boat was laid up with the plant at Catah Shoals.

The following is a summary of the work done by the *Wagner* July 31 to October 25, 1893, viz:

Snags pulled	369
Stumps pulled	111
Logs removed from channel	435
Tree slides removed from channel	24
Shore snags cut	1,222
Leaning trees cut	149
Trees girdled	66

Wrecks removed, viz: Steamer *Idaho* removed from channel at Meyers Plantation.

September 16–21, 1893, the United States dredge *Lone Star*, G. W. Phillips, engineer in charge, was towed by the snag boat *Howell* from Alexandria, La., to the foot of Catahoula Shoals. Dredging at that obstruction commenced September 25 and was continued without serious interruption until January 10, 1894, when a rise of the river necessitated suspension of operations. A preliminary cut, about 35 feet wide, was completed through the shoals, on the east side of the former channel, November 24. As it was impracticable to load and handle barges until this cut was finished, the material was dumped alongside the cut, to be removed later on when the barges should have clear passageway. November 25 the dredge dropped down about 300 feet below the lower dam and commenced excavation on the second cut, dumping the material removed upon barges, which were towed to and unloaded along the right bank, a small steam tug having been hired for moving them. The second cut, 30 feet in width, was completed January 9, 1894, giving a good channel 65 feet wide and 4 feet deep at extreme low water. The material removed consisted of mud, sand, gravel, and rock, and the work done will be best understood by reference to the maps, profile, and cross sections accompanying my report of 1891. (Report Chief of Engineers, 1891, p. 1967.)

The following is a summary of the work done, viz:

Cubic yards of material excavated	29,026
Cubic yards of material deposited along right bank	13,322
Number of barge loads of material moved	356
Stumps and logs removed from channel	83

January 23–28 the plant was towed by the snag boat *Wagner* from the shoals to Monroe, La., that being the most convenient place for making needed repairs of dredge and barges. During the period of high water since, the dredge and barges have been undergoing repairs at Monroe, so as to be ready to resume and complete the work during the low-water period this summer and fall.

The hull of the wooden snag boat *Hooker*, purchased at secondhand in 1888, became so rotten that it was unsafe to keep it afloat longer, and it was beached on the shore of Lake Centennial, just above Vicksburg, in July, 1893. A new hull has been built for the boat, at a cost of $4,000, and was delivered at Vicksburg April 3, 1894.

Under my project of 1892 a party was organized at Vicksburg November 20, 1893, under Assistant Engineer Walter H. Polk, for running a line of precise level between Vidalia and Monroe, La., the cost to be apportioned to the appropriations for Ouachita River and tributary streams and for water gauges. The party proceeded at once to Natchez, Miss., where operations commenced November 20. The line was carried westward along the public road from Vidalia to Concordia Station, and thence along the Natchez, Red River and Texas Railroad to Black River Station, the western terminus, near the junction of Ouachita, Tensas, Little, and Black rivers. By the courtesy of the railroad officials a hand car was furnished for transporting the party to

and from work, lodging and subsistence having been obtained a nearest point practicable as the work progressed. From the hea Black River the line was carried up the Ouachita along the public to Harrisonburg, La., thence along the river bank and through woods to the mouth of Bayou Dan, which was reached Januar Owing to the difficulty of obtaining subsistence and shelter on the it was found impracticable to continue the line upstream with rea able progress, and February 2 and 3 the party was transferred by st boat from Danville to Monroe, where a small quarter boat was obta from the fleet. February 5 the line was started downstream to nect with the line from Vidalia to Danville, and the closure was pleted April 16. The line from Monroe to Danville was run p along the railroad, partly along public roads, and partly along the bank. The permanent reference points of the U. S. Coast and detic Survey, the Mississippi River Commission, and this office at near Natchez and Vidalia were connected with the line, and als permanent points of Red River survey line of precise level at Mo Permanent benches were established along the way, and all old b marks, gauges, and high-water marks that could be found were level

A number of examinations and surveys of Ouachita River have made since 1870, to ascertain the feasibility of improving its na tion, not only locally, but upon some comprehensive plan.

The map of 1870 shows the river from Arkadelphia to the Loui State line; but the absence of any notes, except rough sketches blotter, suggests draftsman's skill in dressing up a reconnoiss rather than trustworthy information. The survey of 1871 was ambitious, and was undertaken with a view to improvement by and dams. It was commenced at Trinity, about 47 miles above River, on August 14, and closed at Camden November 2, cover distance of nearly 300 miles upstream in eighty-one days, wher year in the field would have been too short for the purpose. The were plotted with grotesque effect by distorting the scales 6 to 1- is, 1:5,000 for width and 1:30,000 for length—and the notes a vague that it would be impossible to replot them now to correct The tributaries were ignored, no topographical information obtained, no gauges kept, no borings or discharge measurements and yet, upon this slender foundation, sites for dams, plans and cations for construction, and estimates for a project for ten lock dams were submitted, an appropriation made, and contract en into to begin a work at an intermediate point that might cost anyw from $2,000,000 to $4,000,000. In the meantime, the report o project was reviewed, and the survey condemned by a Board of neers, who recommended further surveys.

The second survey was begun at Camden in the summer of and closed at Trinity December 15, after only one hundred and six days in the field. The instructions of the officer in charge explicit and minute in regard to methods, accuracy, gauges, disch etc., and special order was given to search for and connect with n of the first survey, so that whatever should be found good mig utilized. It is not worth while to review this survey in detail. B a year and a half had passed since the survey of 1871 closed at den, and yet the first mark touched upon by the survey of 187 some 60 miles downstream, and, though the levels showed a dis ancy of over 3 feet, no steps were retraced to discover and fix the but the line was pushed through to Trinity, and the final discre of 2.714 feet was assumed to be the error of the levels of 1871.

Captain Benyaurd, now lieutenant colonel of engineers, submitt

eport in May, 1874 (Report Chief of Engineers, 1874, p. 352), and, while admitting the feasibility of improving Ouachita River by locks and dams, he recommended that the project be abandoned. His objections briefly were: For the original project, faulty location of dams and small size of locks, and for either great cost and the obstruction at the mouth of Red River, the key to the system. The subject has been revived from time to time, but the same objections have been raised and sustained, and the bar at the mouth of Red River still remains.

In December, 1889, Hon. C. J. Boatner, member of Congress from Monroe, called upon the Secretary of War for "estimate of cost of survey of Ouachita River to Camden, Ark., with a view to securing permanent navigation by means of locks." I submitted a report with estimates of $150,000 for an exhaustive survey of Ouachita and its principal tributaries, which form a system that might be developed under the same plan, and which could not be ignored in considering any plan for improving Ouachita by slack-water navigation. This report has been repeated, but will be found in full in the Report of the Chief of Engineers for 1890, pp. 1873–1875.

The subject is being discussed again, and in view of some of the misinformation displayed before the River and Harbor Committee recently by those urging an appropriation for a resurvey, it seems proper to offer corrections in matters of fact, and to state what has been done toward collecting further information.

It was stated at a hearing before the committee on February 2, 1894, that the project was "temporarily abandoned for the alleged reason that the demands of commerce did not justify the costly improvement;" and, again, that "some sort of influence induced the captain of engineers and the Chief of Engineers to change their former indorsement of the project, and to recommend for the present the abandonment of the project for lock-and-dam navigation of the Ouachita."

The project was abandoned by Congress upon the report of Captain Benyaurd, already mentioned, which was explicit and sound.

My report of 1889 was limited to a statement of the cost and need of an exhaustive survey of a system of navigable streams about which little was definitely known except that it was subject to inundations both from its own drainage and from the Mississippi River, and the estimate was small in comparison to the interests at stake.

More has been learned about the rise and fall of Ouachita at certain stations than was known when the report of 1874 was submitted, and some idea of relative heights and average slope has been gained, but the information about high and low water discharge and of the topography of the valley has not been materially increased, especially in that part where the demand for improvement is greatest; yet some of the speakers before the River and Harbor Committee stated that locks and dams could be put in at comparatively small cost, and without danger of overflowing the valley. One of them located five locks and dams offhand, without the slightest evidence that the pools would form a continuous system or that the adjustments would be economical, and supported his statements with the following flight of imagination:

> The opinion, based on practical experience, is verified by a test which must be accepted as infallible. In September, 1885, when the Ouachita River was at a very low stage, the gauge at the mouth of Red River stood at 40 feet, and the backwater reached Pigeon Hills, a distance of 385 miles from the mouth of Red River and 75 miles below Camden.

Mississippi River usually is low in September, as well as the tributaries, but in September, 1885, it happened to be unusually high, reaching the

highest point at Red River Landing September 27, when it stood 20. feet on the gauge, or 19.1 feet less than stated. During the same mont Ouachita happened to be at an unusually high stage for the seaso and on September 27 it had fallen to about 2½ feet above low wate The relation between the zeros of the two gauges has been determine by precise levels, connecting them with the mean gulf level of the Coa Survey at Biloxi, that at Red River Landing being 2.98 feet above i and that at Monroe when the gauge was read being 30.68 feet above t same plane. The water surface, therefore, at Red River Landing at t time of the "infallible test" was 9.1 feet lower than the water surfa at Monroe, 101 miles below Pigeon Hills, and consequently probably least 34 feet below the water surface at the latter, allowing the ve moderate slope of 3 inches to the mile. A stage of 40 feet at Red Riv Landing would be about 16 feet lower than the elevation of the wat surface at Pigeon Hills at its lowest, and if the water ever should backed up to that place from Mississippi River without a dam, most Louisiana and Mississippi would be drowned. The statements bef the same committee in regard to the estimates for the survey, the ne of making it exhaustive, and the examination of the river and study the question by the engineers had as little foundation as the "infalli test."

Conditions have changed somewhat since the early surveys; there greater probability that the Mississippi levees will be maintained, a that Upper Ouachita will have to carry only its own floods and its tr utaries', and there is a reasonable hope that the problem at the mou of Red River will be solved within a year or two. The Ouachita Val is fertile, and with a gain of confidence people doubtless will return it and revive its prosperity. Since my report of 1889 I have mad careful review of the notes of the early surveys to ascertain how mu may be used; precise levels have been run from the Coast Survey ben at Delta Point, opposite Vicksburg, to Monroe and thence down to Tr ity to connect with the line from the Coast Survey benches at Vida opposite Natchez; gauges have been established at Arkadelphia, Ca den, Monroe, Riverton above Columbia, Trinity, and the mouth of Bl River, where the Ouachita system joins the Red, and all but the f two connected with the common reference plane. A map of the val has been compiled, and high and low water marks determined as clos as possible from levee, original, and railroad surveys wherever the li touch the Ouachita or its tributaries. The levels of 1871 and 1873 h been tested by the precise levels, and the recovery of high-water ma of 1874 at Monroe and Trinity and of a bench of each survey has de oped the fact that the Y levels of 1871 between Monroe and Trin were good, while those of 1873 were seriously in error. Taking the f bench at Trinity common to both as zero, the common bench at Cam is 52.8 feet higher by the survey of 1871 and 50.086 by that of 187 discrepancy of 2.714 feet; while if the comparison is made from common bench at Monroe, the levels of 1873 make the bench at C den 1.169 feet higher than those of 1871, and the bench at Trinity 3. feet higher; that is to say, the levels of 1873, starting at the last be of 1871 at Camden, crossed those of 1871 back and forth, making discrepancy −1.169 feet between Camden and Monroe, and +3. between Monroe and Trinity, giving the final discrepancy +2.714.

The precise levels which covered the stretch from Monroe to Trin closing with an error of less than 2 centimeters, say three-quarter an inch, differ from the levels of 1871 by only +0.239 foot, and there confirm them and establish the fact that the levels of 1873 fell short *nearly 4 feet* between Trinity and Monroe. An error of such ma

tude, if undiscovered, might cause an error of 15 or 20 miles in the location of a dam, with the result, on the one hand, that the pool would not back up a navigable depth on the miter sill of the lock above, or, on the other, might drown out the dam above on very slight rises.

It is not possible to locate this error except approximately. The books of 1871 are genuine and bear internal evidences of correct work; those of 1873 have disappeared, and only copies are to be found. While the latter show evidences of cumulative error in leveling, and not a few of arithmetic, it is probable that the great discrepancy was due to accident and that most of it occurred somewhere about Columbia, where the party was overtaken by a sudden rise of 24 feet, of which 7 feet occurred between 8 a. m. November 23 and 8 a. m. November 24, 1873, for, after the recovery of benches some miles below, the differences between successive benches are no greater than should be expected between two sets of ordinary Y levelings, bench 44 of the survey of 1871 being 7.670 feet above bench 1 at Trinity by the levels of 1871 and 7.709 by those of 1873. Similar agreements have been found in comparing short stretches on other parts of the river, so that if we could recover a bench or common high-water mark at Camden the levels of both surveys might be corrected and utilized locally for high and low water, soundings, bank heights, etc. The only way this can be done or any accurate knowledge of the high and low water limits obtained is by precise levels from established benches. Above Monroe the line must begin on the benches of the Coast Survey at Little Rock and follow the Iron Mountain Railroad to the crossing at Arkadelphia, and thence around by rail to Gurdon and Camden. From the latter it should follow the general course of the river and close on the permanent benches at Monroe. On Black River the line should start from the permanent benches lately established at Trinity and continue down some 47 miles to join the system of the Red River survey. Duplicated Y levels may answer for the tributaries and to determine bank heights of the Ouachita between stations. Gauges should be set up on the main river at all critical points and a few on the tributaries, and observed throughout the year, and high and low water gauges at short intervals to be observed at the top of the flood and during the low-water season.

The importance of the work will justify a scale of $\frac{1}{10000}$ for all, and topography should extend for at least a mile on either side of the river, to ascertain the probable direction of overflow and the amount of levee work that might be required, while frequent transvalley sections will be needed to develop the valley between the main river and the tributaries. The profile, with the maps, should indicate whether or not the project is feasible, and the probable site for the first dam, from which the system would be developed.

The success that has followed the use of modified bear-trap dams suggests the opinion that some such form might be adapted to Ouachita River without undue cost for construction and operation and with the least risk of increasing flood heights to a dangerous amount. The range between high and low water is so great on the lower river that fixed dams are out of the question; and, on the other hand, the low water discharge is so small, that movable shutter dams might fail to pool the water unless closed by needles. It must be remembered that Ouachita drains a large territory naturally, and that it is liable to great additions to its flood discharge from crevasses which may pour into it through Bayous Bartholomew, Bœuf, Tensas, and Maçon, and therefore the safest and most economical system would be that which should be nearest to an open river during high water, afford navigable passes at medium *stages, and require* the delay of locking only during the

lower stages. If hydraulic gates are practicable for 12 feet lift an from 100 to 150 feet crest, after the working models displayed in th engineer section of the War Department exhibit at the World's Fair it seems probable that they might be applied to advantage on Ouachit River not only to give a slack-water navigation on the main trunk line but to extend it by a proper choice of sites to the principal tributaries Thus a dam at Trinity would pool the Ouachita, Tensas, and Maçon and Little River to certain distances, depending upon their slopes; a dam at Staffords Point would give slack water in Lower Bœuf River also; a dam at some convenient point above Monroe would benefit the Bartholomew and D'Arbonne at the same time; and so it might be possible to develop this interior system of waterways at a cost hardly more than that for Ouachita alone and at no increase of cost for operating while the increased height of floods for the same discharge should be a minimum.

After careful examination of the subject the conclusion is that it was wise to abandon the project of 1871. What the result would have been from putting fixed dams of 7 feet average lift in a river subject to such great variations of rise and fall upon the scanty information at hand might not be easy to particularize, but the general sum doubtless would have been stupendous disaster upon the first great crevasse from the Mississippi River. To go into the project now, however feasible and meritorious, without full information upon all points, would be to invite endless claims for damages from overflow, attributed to the dams, for lands which perhaps may be submerged by every flood without them.

In commenting upon the early surveys of Ouachita River, it must not be forgotten that methods have improved greatly since then, and that most of this improvement is quite recent. The work of 1871 and 1873 followed the general rule for work of this kind at that time. The approximations that were sufficient for preliminary railroad estimates were assumed to be close enough for river improvement, and similar methods were followed also, because the field parties generally had been employed on railroad surveys. The Delta surveys were no better in these respects than those on the Ouachita; compass and chain and ordinary levels were limits of refinement for instruments; no monuments or permanent marks were made, and the discrepancies between the levels on the east and west banks of Mississippi River in 1873 undiscovered for more than forty years after the results were checked exceeded those between the surveys of 1871 and 1873 on Ouachita River, although the distance covered was much less. Leveling by methods of precision and planting stone marks underground at short intervals is more expensive than the old way, first cost being considered but the work has to be done but once, and the marks will remain undisturbed for years.

To give some idea of the range between high and low water and the relative heights from Arkadelphia to Red River, a distance of about 431 miles, the following table has been made, the plane of reference being the mean gulf level of the Coast Survey, which corresponds to the mean reading of 6.23 feet on the Biloxi gauge, and is 0.3005 meter =0.986 foot below bench F of the Coast Survey and bench 21 of the Mississippi River Commission on a bridge pier of the Louisville and Nashville Railroad, Biloxi Bay. The elevations are approximate from Arkadelphia to Monroe, and accurate from Monroe to Red River Landing. The high water of 1882 is taken as standard high water, being the greatest recorded, and the lowest recorded water is taken without regard to year, assuming the gauge record to be practically *correct.* The increase in range at Monroe is evidently caused by ad

tions from the Bartholomew; that at Riverton, by retardation due to floods in the Bœuf; while that at Trinity is caused by floods from Tensas and Maçon, and backwater from Red and Mississippi rivers.

Table of elevations in feet above C. S. mean gulf level of high water of 1882 and lowest water of record on Ouachita River.

Station.	Distance.	High water.	Fall.	Low water.	Fall.	Range.
	Miles.					
Arkadelphia	0	186.7	.....	161.7	.....	25
Camden	90	117.6	69.1	72.9*	88.8	44.70
Monroe	257	78.9	38.7	30.4	42.5	48.50
Riverton	312	67.9	11	15.6	14.8	52.30
Columbia	316	67.6	.3	.....	.....	.....
Harrisonburg	368	65.2	2.4	.....	.....	.....
Trinity	384	62.1	3.1	6.8	(8.8)	55.30
Mouth of Black River	431	56.2	5.9	5.6	1.2	50.6
Total	431	.....	130.5	.....	156.1	.....

Average fall per mile.	High water.	Low water.
Arkadelphia to Camden	0.77	0.99
Camden to Monroe	.23	.25
Monroe to Riverton	.20	.27
Riverton to Trinity	.08	.08
Trinity to Red River	.13	.03
Arkadelphia to Red River	.30	.36

Accurate discharge measurements have not been made at extreme stages, but it probably is safe to estimate the flood discharge at not less than 100 times that at extreme low water for Ouachita alone, and when crevasses occur in the Tensas Front it may exeeed it more than 150 times. With fixed dams the overfall would be a matter of speculation without an accurate knowledge of the extreme flood discharge, and nobody could predict the stage on which boats could run them, and therefore what height to give the lock walls, but it is evident that the lifts would have to be low, the number largely increased, the pools consequently shortened, the detention and risks enhanced, and the cost of operating multiplied by a large factor.

The original estimate of $150,000 for the survey of the system is repeated; a sum not extravagant for ascertaining the merits and practicability of a project that may involve several millions. On the other hand, the amount would be well spent if it should prevent the inauguration of a work that might prove injurious or from which there should be small hope of adequate returns.

Finally, assuming the work to be of the importance and merit claimed and free from many of the risks mentioned, a thorough survey in advance might save more than its cost in possible extensions of the pools by dredging intermediate shoals, thus reducing the number of dams and consequently the annual charges for operation and repair.

Detailed estimates.

ne dredge	$30,000
wo quarters boats	3,000
pairs of outfit and tools	5,000
penses of snag boats	20,000
penses of chopping parties	9,000
penses of dredge	10,000
ugings, leveling, and reconnoissances	5,000
sistant engineers and draftsmen	4,000
rvey of Ouachita and Black rivers	150,000
ice expenses, stationery, mileage, and contingencies	4,000
Total	240,000

Money statement.

July 1, 1893, balance unexpended	$30,575.98
June 30, 1894, amount expended during fiscal year	19,709.97
July 1, 1894, balance unexpended	10,866.01
July 1, 1894, outstanding liabilities	8.77
July 1, 1894, balance available	10,857.24
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	240,000.00

COMMERCIAL STATISTICS.

Navigation during the fiscal year was reported as follows: From the mouth of Black River, La., to Camden, Ark., from July 1 to August 1, and from November 15 to June 1. Below Monroe, La., light-draft boats ran the entire year.

List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Broadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Ouachita	Stern-wheel.	457.45	189	38	6.5	3 6	10 0	New Orleans and Monroe, La.	31	1,612
City of Camden	do	297	175	35	5.5	2 6	7 6	New Orleans, La., and Camden, Ark.	20	.....
John Howard	do	329.69	180	36	6	2 6	7 6	New Orleans, La., and Camden, Ark.	2	.....
								New Orleans, La., and New London, Ark.	1	.....
								New Orleans and Monroe, La.	5	.....
Josie W	do	156.40	140.9	30.4	4.8	2 6	6 6	New Orleans and Harrisonburg, La.	6	.....
								New Orleans and Blankston, La.	2	.....
								Little Missouri River, Ark., and New Orleans, La.	1	.....
								Monroe and New Orleans, La.	2	
Parlor City*	do	136.30	125	26	3.7	2 6	6 0	Camden and New Orleans.	1	.....
								Boeuf River and New Orleans.	1	.....
								Monroe and Bayou Bartholomew.	1	.....
								Monroe and Boeuf River.	13	.....
Belle of D'Arbonne	do	74.59	111	22	3.7	2 0	4 0	Monroe, La., and Camden, Ark.	25	99
								Monroe and Bayou Bartholomew.	10	19
								Monroe and Bayou D'Arbonne, La.	3	.....
Grover K*	Tug	4	30	7	4	2 4	.....	Trinity and Boeuf River, La.	25	.....
Helen Vaughan	Stern-wheel.	89.95	100.5	25	4.2	1 0	3 6	Monroe and Bayou D'Arbonne, La.	11	.....
								Monroe and Sterlington, La.	1	.....
								Monroe and Bayou Bartholomew, La.	3	.....
								Monroe and Bayou D'Arbonne, La.	5	.....
								Monroe and Bayou Bartholomew, La.	1	.....
H. W. Graves	do	31.22	94.6	17.6	3	1 2	3 0	Monroe, La., and Camden, Ark.	1	.....
								Monroe and Columbia, La.	2	.....

* With barges.

List of steamboats engaged in the trade during the fiscal year—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between.	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Danube	Stern-wheel.	232.32	175	33.8	5.1	2 0	5 6	New Orleans, and Bayou Macon, La.	5	.....
								New Orleans and Boeuf River, La.	3	.....
								Monroe, La., and Camden, Ark.	1	.....
Marco	...do ..	43.90	104.3	19	2.6	1 0	2 0	Monroe and Bayou Bartholomew.	1	.....
								Monroe and Bayou D'Arbonne.	3	.....
Marcus Collins	...do ..	48.14	90	17	2.5	1 1	3 0	Trinity and Tensas River, La.	35	.....
Laura Blanks	...do ..	62.73	104.8	21.3	3.8	1 1	4 0	Trinity and Boeuf River, La.	5	.....
								Trinity and Monroe, La.	2	.....
								Columbia and Mississippi River, La.	16	.....
								Trinity and Bayou Macon, La.	20	.....
								Trinity and Tensas River, La.	16	.....
								Monroe and Pine Bluff, La.	5	12
								Monroe, La., and Marie Saline, Ark.	4	22
Sterling White	Side-wheel.	117.09	120	30.5	4.2	2 0	4 6	Monroe and Ouachita City, La.	31	195
								Monroe and Bayou Bartholomew.	20	.....
								New Orleans and Bayou Bartholomew.	1	.....
Lillie*	Stern-wheel.	61.42	120	26	3.5	2 6	3 6	Trinity and Mississippi River, towing logs.	.....	.....
Gamma*	...do ..	44.32	84	18.4	4.3	2 6	3 6	Monroe, La., and Little River, Ark.	9	.....
E. H. Barmore*	...do ..	171.47	135.7	30.1	5.4	.....	.....	Trinity and Mississippi River, towing logs.	.....	.....
Gasoline Belle	...do ..	8	34	8	.....	0 10	2 4	Monroe and Bayou D'Arbonne, La.	10	.....
Cornelius	...do ..	4	.....	.....	.....	.....	.....	Trinity and Tooleys, La., carrying U. S. mail.	.....	.....
Dora†	Tug ..	3	31	7	4.5	2 8	.....	Trinity and Boeuf River.	3	.....
								Triweekly trips, Jonesville and Tooleys La.		
Eva S	Stern-wheel.	4.50	.....	.....	.....	.....	.....	Ferry	.....	.....
Julia H†	Tug ..	4.88	.....	.....	.....	.....	.....	No report	.....	.....
H. M. Townsend*	Stern-wheel.	87.70	116.7	18	3.1	.....	.....	New Orleans, La., and Camden, Ark.	1	.....
Joe†	Tug ..	18.07	44.5	10	4	5 6	5 9	New Orleans and Boeuf River, La.	2	.....
Chas. D. Shaw	Stern-wheel.	186.03	132	25	4	1 8	4 0	Natchez, Miss., and Monroe, La.	1	25
								Monroe and Ouachita City, La.	2	.....
								Monroe, La., and Marie Saline, Ark.	3	.....
								Monroe and Alabama Landing, La.	1	.....
Addie	...do ..	12.54	81	18	2	0 11	2 6	Monroe, La., and Champagnolle, Ark.	1	.....
								Monroe, La., and Moro Bay, Ark.	1	.....
								Monroe and Chenier, La.	1	.....

*Towboats. † With barges.

A 10-ton barge, propelled by hand, made about 15 round trips between Monroe and Ruggs Bluff, Bayou D'Arbonne, Louisiana.

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.	1888–'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	11,176	11,383	21,890	21,433	16,652	17,786
Cotton seed	3,645	4,423	5,577	6,593	5,058	2,660
Hides and skins	72	4	7	25	36	23
Live stock	549	845	89	172	62	213
Lumber	262	18,000	461	16,388	7,951	5,903
Saw logs	23,257	28,000	26,880	120,000	50,000	.....
Staves	31,519	9,378	23,402	17,888	21,159	8,599
Rock	.....	.....	.....	18,000	.....	.....
Miscellaneous	6,572	5,251	5,197	10,856	783	1,096
Total down freight	82,052	77,284	83,503	211,355	101,701	36,342
Return freight	13,808	11,157	18,317	27,842	40,766	24,228
Total	95,860	88,441	101,820	239,197	142,467	60,570
Estimated value	$3,430,000	$4,466,000	$6,680,600	$9,130,000	$10,234,250	$8,798,000

Saline River is developing an appreciable commerce. The freights for the fiscal year 1893–'94 are estimated at 12,000 tons, the value of which is about $250,000.

The competing lines of transportation are as follows: Ouachita River is crossed by the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark., by the St. Louis Southwestern Railway (Cotton Belt Route) at Camden, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Monroe, La. The St. Louis, Iron Mountain and Southern Railway has a branch line parallel to the river from El Dorado to Gurden, Ark., and thence by the main line to Arkadelphia. A projected extension of this branch will give direct communication with the Mississippi River at Arkansas City, Ark., the part to be built being from Camden to Warren, Ark., a distance of about 50 miles. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) connects with Arkansas City at McGehee, 12 miles west, and thence runs in a southwesterly direction about mid-way between Bayou Bartholomew and Bœuf River, touches the Ouachita River and crosses the Vicksburg, Shreveport and Pacific Railroad at Monroe, La., and continues down, parallel to the main river, to Columbia, La., crossing at Riverton, miles above Columbia, and runs thence to Alexandria, La. The Natchez, Red River and Texas Railroad (narrow-gauge) runs from Black River Station, opposite Trinity, to Vidalia, La., on Mississippi River opposite Natchez, Miss. The New Orleans and Northwestern Railway is completed from Natchez, Miss., to near Bastrop, La., and crosses Tensas River near its mouth and Bœuf River about 2 miles north of Rayville, La.

V 4.

IMPROVEMENT OF BAYOUS D'ARBONNE AND CORNEY, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the south, middle and north, or Corney branches, near Farmerville, Union Parish, northern Louisiana, flows in a southeasterly direction, and enters Ouachita River 6 miles above Monroe, La. The course of the bayou is very tortuous, through an alluvial bottom, varying in width from 1 mile at the head of navigation to 5 or 6 miles at its mouth, which is overflowed during high water to a depth of from 5 to 15 feet. In its windings the stream touches the hills at several places, which serve as shipping points for the country back of them.

An examination and a survey, directed by river and harbor act of 1882, were made in 1883, and the project for improvement was based upon the latter. The bayou is navigable only at high stages, and it was believed that by the removal of snags, logs, wrecks, and leaning

nber from Stein Bluff, on the Corney Branch, to the mouth of the ıyou, 42½ miles, the boating season would be lengthened two months ıd navigation made less hazardous at all times. The estimated cost such improvement was $15,000, if spent in two consecutive seasons. leport Chief of Engineers, 1884, pp. 1372–1381.)

The following appropriations have been made:

act of—	
July 5, 1884	$5,000
August 5, 1886	2,000
August 11, 1888	2,000
September 19, 1890	2,000
July 13, 1892	4,000
Total	15,000

The improvement was begun in the autumn of 1884; the first work ɛt by contract, at a cost of $197.50 per mile) commenced at the mouth, as carried upstream about 23 miles, and suspended December 11, 84. This work having shown that the contract method was not well lapted to the class of work required and not the most economical eans of carrying out the project, subsequent operations were con- ıcted by hired labor. The appropriation of 1886 was expended that ll and the following summer in going over the lower 23 miles of the ıyou and continuing the work upstream about 6 miles. In the sum- er of 1889 operations were resumed and carried up to Stein Bluff. In ecember, 1890, a chopping party was sent to go over the work, navi- ıtion having been reported much obstructed by fallen timber. Work mmenced at Stein Bluff January 7, 1891, and was carried downstream out 9 miles, when rainy weather set in and operations had to be sus- ıded on account of high water, and were not resumed to the end of ıt fiscal year. In August and September, 1891, the entire stretch m Stein Bluff to the mouth was worked over thoroughly at a low ge of water.

Considerable work had been done by steamboat men in the way of ıring leaning timber and removing the worst snags before the ıprovement was undertaken by the United States, and in 1883 the ou was reported navigable from six to seven months of the year. work done by the United States extended the period of navigation y one month, enabled boats of double the capacity of those formerly d to run in the stream to advantage and with less risk, shortened time of trips, and reduced freight rates one-half.

ince the improvement was carried up to Stein Bluff navigation of Corney Branch has extended upstream to Cobb Landing, about 16½ es above, and the act of 1892 provided that $1,000 should be expended improvement of that stretch. The survey of 1884 extended above n Bluff to Harris Bluff, 4 miles below Cobb Landing, and the esti- ted cost of removing the obstructions by one season's work was 00, but it was considered of doubtful utility at that time. (Report ef of Engineers, 1884, pp. 1376–1381.)

During the fiscal year ending June 30, 1894, operations were con- ued, under the supervision of Overseer F. L. Baugh, as follows:

The water having fallen to a stage favorable for work, and the quar- boat formerly used on Upper Ouachita River having been repaired dvance, a chopping party was organized at Monroe, La., September 1893, and the boat was moved up into Bayou D'Arbonne as far as the ge of water would permit. Teams then were hired, and the outfit d supplies were hauled overland to Key's Mill on Bayou Corney, 1 le below Cobb Landing. Operations commenced at Cobb Landing

September 7, and between that date and September 30, were carried downstream to Stein Bluff. Some little work had been done in this stretch by the steamboats running to Cobb Landing, but the bayou was found badly obstructed by leaning trees, shore and channel snags, stumps, logs, a rock fish-trap dam, and the wreck of the steamboat *Sallie*. The water was at the lowest stage throughout the month, and the worst of these obstructions were removed, special attention having been given those in the channel, as the limited amount available would not permit the extensive shore work needed.

The following is a summary of the work done in Bayou Corney between Cobb Landing and Stein Bluff, viz:

Snags and logs removed from channel	170
Stumps removed from channel	515
Fish-trap dam removed	1
Shore snags cut	1,046
Leaning trees cut	3,524
Trees girdled	4,680

Wreck removed, viz: Steamer *Sallie*, below Clark Landing; destroyed with explosives.

Respecting the benefits derived from this work, Capt. H. D. Vaughan, engaged in the steamboat trade between Monroe and Cobb Landing, stated that it not only lessened the danger of navigation greatly, but enabled boats to run to the latter place on a stage 2 feet lower than formerly.

October 1 to November 25, 1893, the work of the chopping party was continued downstream from Stein Bluff to the mouth of D'Arbonne, the favorable condition of very low water continuing throughout that period. Besides leaning trees and shore snags, the channel was found much obstructed by cypress stumps and sawyers, the latter being especially dangerous on account of their shifting nature. All snags and stumps that could not be pulled out and cut up were destroyed with explosives, and the "cut-offs" (spaces cleared across long bends to facilitate high-water navigation) were freed of growing timber and brush.

The following is a summary of the work done between Stein Bluff and the mouth of D'Arbonne, viz:

Snags and logs removed from channel	256
Stumps removed from channel	2,515
Shore snags cut	1,210
Side jams removed	1
Leaning trees cut	3,446
Leaning trees topped	35
Trees girdled	1,870
Square yards willows and brush cut	3,725

This work was done at the lowest stages of water at which any party has been employed in the bayous, which accounts for the large number of stumps removed from the channel, and Overseer Baugh reports that the steamboat men are well pleased with what has been done and state that the past season's work has enabled them to run to Stein Bluff on stages 2 to 3 feet lower than before.

The work is not permanent, as new obstructions are added from time to time, but as the original project for benefiting high-water navigation has been completed, no estimate is made for continuing operations.

Money statement.

July 1, 1893, balance unexpended	$4,125.06
June 30, 1894, amount expended during fiscal year	2,890.51
July 1, 1894, balance available	1,234.55

COMMERCIAL STATISTICS.

The bayous were reported navigable from December 1 to June 30 in the past fiscal year. Cobb Landing is considered the head of navigation on Bayou Corney, and Colvin Landing on Bayou D'Arbonne.

List of stern-wheel steamboats engaged in navigating Bayous D'Arbonne and Corney in the fiscal year 1894.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
		Feet.	Feet.	Feet.	Ft. in.	Ft. in.			
Belle of D'Arbonne	74.59	111	22	3.7	1 0	2 6	Monroe and Farmerville	3	16
Helen Vaughan	85.95	100.5	25	4.2	1 0	3 6	Monroe and Cobb Landing	11	....
H. W. Graves	31.22	94.6	17.6	3	1 2	3 0	Monroe and Shiloh	5	....
Marco	43.90	104.3	19	2.6	1 0	2 0	do	3	....
Gasoline Belle	8	34	8	.....	0 10	2 4	Monroe and Cobb Landing	10	....
Addie	21.66	84.1	18	2	1 2	3 0	Monroe and Farmerville Monroe and Lawrence Ferry Monroe and Colvin	9 3 4	....

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.	1888–'89.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Cotton	1,297	1,839	2,610	2,738	1,500	2,500
Cotton seed	637	180	.....	500	1,000	.....
Hides	.....	.....	.....	4	.....	5
Lumber (logs)	4,500	16	1,123	9,000	10,250	.....
Cotton-seed meal	200	250	150	.....	.....	.....
Staves	745	.....	10	.....	.....	.....
Miscellaneous	1,227	1,893	668	543	.....	.....
Total down freight	8,606	4,178	4,561	12,785	12,750	2,505
Return freight	888	1,324	1,697	1,187	1,666	1,670
Total	9,494	5,502	6,258	13,972	14,416	4,175
Estimated value	$266,000	$440,000	$617,240	$683,500	$616,000	$500,000

The bayous are the only available means for transporting crops and supplies except by hauling long distances in wagons to the Vicksburg, Shreveport and Pacific Railroad on the south, to the branch railroad at El Dorado, Ark., or to the Ouachita River.

V 5.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

Bayou Bartholomew has its source in Jefferson County, southeastern Arkansas, within a few miles of Pine Bluff, and, following a tortuous course, flows at first nearly parallel to Arkansas River, at a distance

varying from 15 to 30 miles, then parallel to the Mississippi, at about the same average distance, but after entering Louisiana turns to the southwest and finally enters Ouachita River in Morehouse Parish, opposite Ouachita City. The total drainage area of the bayou and tributaries is about 1,800 square miles. The States of Louisiana and Arkansas made expenditures at various times for its improvement, navigation of the stream having been carried on to considerable extent as early as 1843.

Examinations of the bayou were made in accordance with requirements of river and harbor acts as follows: From its mouth to the Arkansas State line, act of March 3, 1871; from Baxter, Ark., to its mouth, acts of June 18, 1878, and June 14, 1880; and above Baxter to the Lincoln County line, Arkansas, act of July 5, 1884. Reports upon these examinations are contained in reports of the Chief of Engineers, viz: 1872, pages 383–386; 1879, pages 997–1003; 1881, pages 1453–1457, and 1885, pages 1548–1552.

The project for the improvement adopted in 1881 contemplated the removal of snags, logs, wrecks, leaning timber, etc., to give safe navigation from Baxter, Ark., to the mouth, a distance estimated to be about 150 miles. The original estimate of cost for two consecutive seasons' work was $26,862, but as new obstructions are added every year no estimate for permanent improvement has been made.

The following appropriations have been made:

By act of—	
March 3, 1881	$8,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	5,000
September 19, 1890	5,000
July 13, 1892	5,000
Total	38,000

The work was commenced by hired labor July 20, 1881, at Baxter, Ark., and was carried downstream to Bartholomew, Ark., where operations were suspended December 25, 1881, by high water. Operations were resumed August 29, 1882, at the latter place, and were continued downstream to Lind Grove, La., and discontinued December 1, 1882, by high water. Owing to lack of funds nothing further was done until the appropriation of 1884 was made, when it was decided to give the contract system a trial upon this and other tributaries of Ouachita River. Contract was let for the removal of obstructions at $75 per mile, and work commenced at the mouth November 10, 1884, extended upstream 66⅔ miles, and was suspended December 7, 1884. Nothing was done the following year, as no appropriation was made, and operations were not resumed until November 20, 1886. The contract method having failed to prove satisfactory or economical to the United States, a chopping party commenced work at the mouth on the latter date and continued upstream until stopped by high water, January 20, 1887, at Point Pleasant, La. Operations were resumed July 25, 1887, at Poplar Bluff, Ark., and continued downstream to Point Pleasant, and suspended September 10, 1887, the funds being exhausted. Nothing further was done until August 6, 1889, when a chopping party commenced work at the mouth, continued upstream about 90 miles to Oak Landing, and there suspended operations November 21, 1889. In February, 1890, the U. S. snag boat *Hooker* made a patrol as high as Ohio Landing, Ark., about 118 miles above the mouth, removing

of drift, etc. Operations were resumed by a chopping party May 891, at Portland, Ark., about 35 miles below Baxter, and carried ıstream to the mouth, and suspended August 14, 1891. No work done during the fiscal year 1893.

'om the foregoing it will be seen that operations from 1881 to 1891 nded over the entire portion of the bayou included in the project, that the worst stretches were worked over two and three times, ıot thoroughly and in two consecutive seasons, as was contemplated. intermittent work, however, benefited navigation to a great extent. average duration of the navigable season before the improvement menced was three months; the work gave better navigation for ıt six months, and boats of double the capacity of those used ıerly made trips with greater safety in half the time; and freight s were reported to have been reduced 50 per cent.

uring the fiscal year ending June 30, 1894, operations were con- ed, under the supervision of Overseer Watkins Decker, from August October 31, as follows:

he quarter boat that had been in use on the tributaries to Ouachita ɛr since 1888 having become so rotten as to be unfit for further ice, one of the Red River quarter boats was loaned for temporary on this work, and July 23–31, 1893, it was towed by the U. S. snag *Wagner* from Alexandria, La., to Marble Place, on Bayou Barthol- w, about 20 miles above its mouth. As it was impracticable for snag boat to proceed further upstream on the low stage of water, quarter boat was cordeled up the bayou from that point, progress ing been slow on account of the swift current and numerous ructions. At the following places the stream was blocked with n timber and drift, which had to be cleared away before the boat ld pass, viz: Jones Place, Mound Place, Peterkin's, State Line, r's, Jim Smith's, Green Goodwin's, Normandy, Alex Arnett's, De ıpert, Marion, Bloomers, and Dr. Shearer's. August 22, at the kins Place, Ark., about 2 miles below McCombs Landing, the boat ck a snag and sank. Efforts were made to save it, but without ess, and the hull broke in two. The wreck was dismantled and greater portion of the cabin was saved and used in building a new t, which was finished in September. The hull was destroyed with losives so as not to obstruct navigation. After the boat sank the ty camped in tents along the bank, and teams were hired to move outfit and supplies from point to point, until the new quarter boat completed. The season's operations extended from McCombs ding, some 30 miles below Baxter, Ark., ordinarily considered the d of navigation, to the mouth, and consisted of cutting, girdling, destroying leaning timber, stumps, shore snags, logs, and brush ıg the banks, and removing and destroying snags, logs, stumps, trees in the channel. The water was at very low stages through- the entire period the party was at work, and all conditions were emely favorable for the removal of obstructions. Successive high ds had passed over the bayou during the year, and Overseer Decker ɔrted that never before in his experience had he seen a stream so ly obstructed by fallen timber throughout its entire length. Many he trees reached from bank to bank at the low stage of water, and e were from one to a dozen between all landings. Between Alex ett's and Normandy Landing, and at the Arkansas and Louisiana were the most obstructed portions. Just below Arnett's a jam 150 long was removed August 17, on the way up, but September 20, at ıge about 2 feet lower, *it was found* jammed at the same place.

The water then being too low to float the drift away, it was pulled out on the banks and cut into short lengths. Within a distance of 3 miles below, 25 large trees were removed from the channel and destroyed. At the State line a cyclone had passed, and for a distance of half a mile nearly every tree along the west bank had blown into the stream.

The following extract is taken from Overseer Decker's report, viz:

The greater portion of the labor was employed in removing channel obstructions, the work along the banks consisting chiefly of girdling trees and cutting stumps and shore snags. Logs, snags, and stumps in the channel were destroyed with explosives, and shore snags and stumps either were cut or destroyed. Logs lying along the bank were cut into short lengths so as to float away when the water rises, or destroyed to prevent their becoming snags.

In the past this stream has been more thoroughly worked from Lind Grove to the mouth, and I noticed considerable improvement in the depths on bars as a result. About a mile above Mound Gin is a very shoal bar. Four years ago I found but 6 to 8 inches of water on this bar, but this year, at a lower stage, I found a well-defined channel with 14 inches of water, the increase having been gained by the removal of logs. The shoalest bar in the stream is at the Wells Place, which was cleared of logs four years ago, but others had lodged there since and were removed this year, and there had been no change in the depth, which was but 6 inches. At Boone Ford I found 18 inches of water, where there was but 8 inches four years ago, and from Point Pleasant down to the Jones Place I found an increased depth of 4 to 5 inches, as compared with former years. At the Fifer Place is a rock bar on which I found 10 inches of water. This bar has not changed, as the formation is too hard to scour, and it creates a shoal about a half mile long below. If the rock bar was deepened the shoal below would disappear, as it is formed of nothing but sand. Below Capt. Ford's to the mouth I found 14 to 16 inches of water.

As to beneficial results to navigation obtained by this season's work, I have to say that navigation of the stream now is comparatively safe at medium and high stages of water. To make it safe at low stages will yet require a large amount of money. The improvement is not permanent, and the removal of snags, which will form in a heavily timbered stream, is needed from year to year to keep it in safe navigable condition.

The greater portion of the commerce has been detracted by the Houston, Central Arkansas and Northern branch of the Missouri Pacific Railway, running along the east bank, owing to the late period at which the bayou usually reaches a navigable stage. If there was navigation at the time planters begin to move their crops the steamboats would control the greater portion of the trade. The above facts were learned from conversation with the planters along the stream, who do not seem to be satisfied with the railroad as a carrier.

The following is a summary of the work done during the year, viz:

Snags removed from channel	11,881
Stumps removed from channel	713
Logs and trees removed from channel	1,174
Jams removed	3
Shore snags and stumps removed	17,603
Logs cut up	21,905
Leaning trees cut	7,652
Trees girdled	35,462
Square yards brush and willows cut	8,225

Wrecks removed, viz, flatboat at Portland, Ark., and sunken quarter boat at Perkins Place, Ark.

Money statement.

July 1, 1893, balance unexpended	$5,348.10
June 30, 1894, amount expended during fiscal year	4,314.03
July 1, 1894, balance unexpended	1,034.07
July 1, 1894, outstanding liabilities	.24
July 1, 1894, balance available	1,033.83
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

COMMERCIAL STATISTICS.

Bayou Bartholomew was reported navigable from December 1 to June 1 in the past fiscal year.

List of steamboats engaged in navigation during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
Sterling White	Side-wheel.	117.09	120	30.5	4.2	2 0	4 6	Monroe and McComb Landing.	20	....
Belle of D'Arbonne	Stern-wheel.	74.59	111	23	3.7	2 0	4 0	Not reported	10	19
Helen Vaughan	...do..	85.95	100.5	25	4.2	1 0	3 6	Monroe and Red Bluff	1	....
								Monroe and Elders	1	....
Parlor City	...do..	136.30	125	26	3.7	2 0	6 0	Monroe and De Siard	1	....
H. W. Graves	...do..	31.22	94.6	17.6	3	1 2	3 0	Monroe and Vesterland.	1	....
Marco	...do..	43.90	104.3	19	2.6	1 0	2 0	Monroe and McComb Landing.	1	....

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	2,434	1,000	2,372	3,971	2,000
Cotton seed	2,991	1,300	3,326	2,467	4,000
Cotton-seed meal	.....	.....	1,425	516	.....
Saw logs	159	2,000	4,450	20,080	11,839
Staves	2,569	2,375	1,648	17,822	.....
Miscellaneous	665	175	410	1,340	.....
Total down freight	8,818	6,850	13,631	46,196	17,839
Return freight	3,469	825	1,534	3,103	4,000
Total	12,287	7,675	15,165	49,299	21,839
Estimated value	$564,000	$136,000	$515,000	$826,000	$492,700

This stream is crossed at Baxter, Ark., the upper limit of improvement, by a branch of the St. Louis, Iron Mountain and Southern Railroad, which connects with the Mississippi River at Arkansas City, Ark., runs west 56 miles to Warren, Ark., and probably will be extended to Camden, on the Ouachita, which is connected with the main line by a branch to Gurden, Ark. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) runs parallel to Bartholomew from McGehee, Ark., to Monroe, La. The New Orleans and Northwestern Railway has been completed to near Bastrop, La., and crosses the Houston, Central Arkansas and Northern Railroad at Kellars, La., 7 miles south of Bastrop.

V 6.

IMPROVEMENT OF BŒUF RIVER, LOUISIANA.

Bœuf River has its source in Chicot County, southeastern Arkansas, flows in a general southwesterly direction, and enters Ouachita River at Stafford Point, 8 miles above Harrisonburg, Catahoula Parish, La. The improvement of this stream was undertaken by the State of Louisiana more than half a century ago, the report of the board of public works of 1840 stating that it had been opened to Point Jefferson.

An examination was made in 1880, in accordance with requirements of river and harbor act of June 14, 1880 (Report Chief of Engineers, 1881, pp. 1424–1428), and the project based thereon contemplated removing snags, logs, leaning timber, etc., obstructing navigation at high stages from Wallace Landing to the mouth, a distance estimated to be about 152 miles. The cost of removing the obstructions in two consecutive seasons was estimated at $20,000, but as new obstructions are added every year and require removal from time to time, no estimate for permanent improvement has been made.

River and harbor act of July 5, 1884, directed an examination of three outlets near Point Jefferson, Louisiana, with a view to closing them. The report thereon recommended the closure of the outlets as necessary to preserve navigation in the stream (Report Chief of Engineers, 1885, pp. 1545–1548), and this addition to the project was approved by act of 1886, which provided for "continuing improvement, and for closing Outlet Number One."

The following appropriations have been made:

By act of—	
March 3, 1881	$5,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	6,000
September 19, 1890	5,000
July 13, 1892	10,000
Total	41,000

The improvement was commenced, by hired labor, at Point Jefferson in August, 1881, and work of a chopping party was carried downstream about 100 miles, and suspended at the close of November, 1881, when the available funds were exhausted. Operations were resumed September 9, 1882, and between that date and December 20, 1882, the portion of the river above the railroad crossing near Girard, La., to Point Jefferson was worked over by a chopping party. Nothing further was done until appropriation was made by act of 1884, when it was decided to give the contract method a trial upon the tributaries to Ouachita River. On Bœuf River the work was let at $75 per mile; operations commenced November 15, 1884, at the mouth, extended upstream 60 miles, and were suspended December 11, 1884. The next appropriation provided for continuing the improvement and closing Outlet No. 1, but after a reexamination it was found essential that all three outlets be closed, and, by uniting with the planters whose lands would be protected, this was done in 1887 and 1888, the proportion of cost borne by the United States having been $5,441.78. Outlet No. 1 was closed substantially, the second outlet was closed by a heavy dam, and the third by a low dam, which was all the work that could be done with the insufficient appropriation and the assistance rendered by the planters. The removal of obstructions, by hired labor, was resumed November 8, 1888, and between that date and May 22, 1889, operations were carried from Point Jefferson to the mouth, but work was suspended from January 1 to April 25, 1889, by high water. The small balance available was expended in December, 1889, for operations of the snag boat *Hooker* in working over the 60 miles above the mouth. September 28 to December 12, 1891, a chopping party worked from the mouth up to a point 9½ miles above the Vicksburg, Shreveport and Pacific Railroad bridge. The water was at a low stage during the entire period, and thorough and effective work was done.

The total amount expended to June 30, 1893 (including outstanding liabilities of $22.54), was $30,862.51, which enabled steamboats to run to Point Jefferson at high stages with greater safety, and below the Vicksburg, Shreveport and Pacific Railroad bridge they could navigate at any stage high enough to permit them to cross the bars without danger, at a saving of at least thirty-six hours' time on the round trip.

The closure of the 3 outlets at Point Jefferson in 1887–'88 gave immediate benefit to navigation by confining the flow to its natural course and by scouring the bars below, but during the overflow from Mississippi River in the spring of 1890, caused by breaks in the levees, all the dams were destroyed. As it is essential that all the outlets be closed substantially and at the same time, and as sufficient funds for the purpose have not been available at any time since the dams were destroyed, it was decided to defer the work until a specific appropriation should be made for rebuilding the dams. The last examination was made in April, 1893, the results of which, briefly, are as follows:

The dam at Outlet No. 1 washed away to about the height of ordinary low water, except the south wing. The dam at Outlet No. 2 was standing, but the old levee and bank on the west side showed a deep wash below low water. The dam at No. 3, built by a planter to back water up Bayou Bonne Idee to get a steamboat in for cotton, was not expected to withstand high water; but if appropriation had been made according to the original estimate for closing all 3 outlets at the same time, it would have been raised above flood height and done much to insure the safety of the system. All the outlets should be closed and connected by a line of levee at least 3 feet above highest water, extending above No. 3 to the nearest high ground and below No. 1 far enough to prevent back wash on the dam. To close No. 1 alone, as first provided by Congress, is not only to waste money but to invite disaster. The estimated cost of the work required, as given in my last report, was $30,000. (Report Chief of Engineers 1893, p. 2017.)

During the fiscal year ending June 30, 1894, work for the removal of obstructions to navigation was continued as follows:

After suspending operations in Bayou Bartholomew, the chopping party, under Overseer Watkins Decker, was transferred to Bœuf River, November 1–11, 1893, the quarter boat was dropped down the Ouachita from the mouth of Bartholomew to the mouth of Bœuf River, stopping at Monroe November 2–4 to receive supplies and make needed repairs of the boat and outfit. Two days were spent in transferring worn out and surplus property to the snag boat *Wagner* at Catahoula Shoals, a few miles below Bœuf River, after which the boat commenced working upstream November 13. Work was continued until January 6, 1894, and was carried from the mouth up to Winters Place, about 10 miles above the Vicksburg, Shreveport and Pacific Railroad bridge. During this period the river was at a low stage, favorable for work, and all dangerous obstructions were removed. The wreck of the steamer *Era No. 10*, burned in January, 1892, about a mile above McIntosh Place, was destroyed with explosives December 1, 1893. Not a great amount of leaning timber needed to be cut, as the banks along this stretch were well cleared in 1891. The part of the stream worked over has been benefited greatly, and is in safe condition for navigation at any stage high enough to permit steamboats to run.

A rise having set in, preventing further work to advantage, the quarter boat was dropped down to Vicksburg, Shreveport and Pacific Railroad bridge, near Girard, La., January 8, where the party was dis-

banded. Nothing further has been done, as the stages of water have been too high for effective work.

The following is a summary of the work done between November 13 and January 6, viz:

Snags removed from channel	2,487
Shore snags removed	5,700
Stumps destroyed	3,828
Logs destroyed	3,024
Leaning trees removed	3,879
Trees girdled	4,102
Square yards willows and brush cut	2,050

Wreck removed, viz, steamer *Era No. 10.*

Money statement.

July 1, 1893, balance unexpended	$10,160.03
Received on account of overpayment to land-grant railroad	1.45
	10,161.48
June 30, 1894, amount expended during fiscal year	3,956.75
July 1, 1894, balance available	6,204.73
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	40,000.00

COMMERCIAL STATISTICS.

Bœuf River was reported navigable from January 9 to May 15 in the past fiscal year.

List of steamboats engaged in navigation during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*		
Parlor City	Stern-wheel.	136.30	125	26	3.7	2 0	6 0	New Orleans and Bœuf River.	1
								Monroe and Mrs. Jordan's.	13
								Monroe and Point Jefferson.	1
Laura Blanks	...do ..	62.73	104.8	21.3	3.8	1 1	4 0	Trinity and Charlieville	5
Danube	...do ..	232.32	175	33.8	5.1	2 0	5 6	New Orleans and Girard	3
Joe	Tug ..	18.07	44.5	10	4	5 6	5 9	New Orleans and Latchera Creek.	2
Dora	...do ..	3	31	7	4.5	2 8	.....	Trinity and Charlieville	2
Grover K	...do ..	4	36	7	4	2 4	.....	...do	25

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.	1888–'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	900	626	1,563	1,760	1,397	1,084
Cotton seed	2,550	1,878	1,178	716	731	834
Hides and skins	.....	.....	50	.....	.....	.....
Live stock	12	.....	19	.....	.....	.....
Lumber	300	250	1,352	.....	.....	.....
Saw logs	.....	.....	1,223	.....	.....	.....
Staves	4,626	923	3,138	1,777	263	54
Miscellaneous	450	300	72	179	.....	91
Total down freight	8,838	3,977	8,615	4,432	2,391	2,063
Return freight	650	335	1,370	3,458	1,594	1,376
Total	9,488	4,312	9,985	7,890	3,985	3,439
Estimated value	$350,000	$300,000	$501,000	$636,500	$580,850	$457,100

The Vicksburg, Shreveport and Pacific Railroad crosses Bœuf River near Girard, La., and the New Orleans and Northwestern Railway crosses about 2 miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west, and a line is projected (Louisiana, Arkansas and Missouri Railroad) which will touch the river at several points on the east.

V 7.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

Tensas River has its source in Lake Providence, in northeastern Louisiana, within 2 miles of the Mississippi River, flows in a general southerly direction, gradually diverging from the Mississippi, and joins Ouachita and Little rivers at Trinity, La., in forming Black River. Bayou Maçon was united under the same head of appropriation with Tensas River by the act of 1884. This stream rises in Desha County, southeastern Arkansas, near the source of Bœuf River and a few miles west of the Mississippi, flows in a general southerly direction west of and nearly parallel to the Tensas, and enters the latter about 40 miles above its mouth.

In accordance with river and harbor act of June 14, 1880, examinations of both streams were made in 1880, upon which the plan for their improvement is based. The project contemplated removing snags, logs, and leaning timber obstructing navigation, in Tensas River, from Dallas, La., to its mouth, about 134 miles, at an estimated cost of $23,000; and in Bayou Maçon, from Floyd, La., to its mouth, about 98 miles, at an estimated cost of $17,000. (Report Chief of Engineers, 1881, pp. 1457-1467.) The estimates were based upon calculations for continuous work in one low-water season, and, in view of the appropriations made, are without value, as new obstructions are added every year and require removal in the interest of safe navigation from time to time.

The following appropriations have been made:

By act of—	
March 3, 1881	$3,000
July 5, 1884	4,000
August 5, 1886	4,000
August 11, 1888	5,000
September 19, 1890	5,000
July 13, 1892	5,000
Total	26,000

The improvement of Tensas River was commenced by hired labor in September, 1881, at Dallas, La., where the Vicksburg, Shreveport and Pacific Railroad crosses the river; work was carried downstream to near Buckner Place and suspended the latter part of December, 1881. The next work was let by contract, at the rate of $125 per mile; operations commenced at the mouth October 29, 1884, were carried upstream about 29 miles, and suspended November 28, 1884. The contract method failed to prove satisfactory or economical for the class of work required in these streams, and subsequent operations were conducted by hired labor. As no work had been done in Bayou Maçon, the appropriation of 1886 was applied to that stream. Operations commenced November 14, 1886, and were suspended the latter part of January, 1887, work during this period having extended from Floyd to the mouth of the bayou. In October, 1887, this work was gone over from Floyd down to Oakley, about 22 miles above the mouth, operations consisting chiefly of the destruction of accumulations of drift, most of which was burned. Work was resumed February 1, 1889, and continued until April 22, 1889, extending over the entire portion of Bayou Maçon included in the project and about 25 miles of Tensas River between Mound Bayou and Tensas Bluff. The wreck of the steamboat *H. J. Dickey* was removed from Bayou Maçon, near Delhi, La., December 17, 1891, and from December 29, 1891, until January 12, 1892, a chopping party was employed in removing obstructions, chiefly in the channel, from the lower 40 miles of Bayou Maçon, work having been stopped the latter date by high water. August 22—December 22, 1892, a chopping party worked over Bayou Maçon from Floyd down to Oak Bluff Bayou, about 16 miles above the mouth, where operations were suspended by high water, and continued high stages prevented anything further from being done to the end of that fiscal year.

The total amount expended to June 30, 1893, was $24,424.64, of which $7,529.25 were applied to improving Tensas River and $16,895.39 to Bayou Macon. With these expenditures Bayou Maçon and the Tensas, below its mouth, were put in fairly good navigable condition, enabling steamboats to make quicker trips into the Maçon, the principal commercial branch, during the navigable season, with comparative ease and safety.

During the fiscal year ending June 30, 1894, operations were continued as follows:

After suspending operations in Bayou D'Arbonne, the chopping party that had been employed on that work was transferred to Tensas River. The quarter boat was dropped down Ouachita River to the mouth of Tensas, reaching the latter point December 11, 1893. Operations were carried on under the supervision of overseer F. L. Baugh, were continued until January 30, 1894, and extended upstream to Tensas Bluff, ordinarily considered the head of navigation, about 75 miles above the mouth. From the mouth up to the New Orleans and Northwestern Railway bridge at Clayton no work was required beyond the removal of a mud lump at Hunter's Bar, which was destroyed with explosives. Above the bridge work consisted of cutting leaning timber and shore snags and removing snags, logs, and stumps from the channel, but the limited amount of funds available permitted the removal only of the worst of these obstructions.

The following is a summary of the work done, viz:

Snags and logs removed from channel	280
Stumps removed	711
Shore snags cut	594

Jams removed	2
Side jams removed	1
Mud lumps destroyed	1
Leaning trees cut	1,527
Leaning trees topped	27
Trees girdled	847
Square yards willows and brush cut	375

This work lessened the danger of navigation greatly, and will enable boats to make faster time.

Although new obstructions are added from time to time, it is believed that, with the balance of the original estimate ($14,000) in one appropriation, both streams may be cleared of obstructions so thoroughly as not to need further attention for years.

Money statement.

July 1, 1893, balance unexpended	$1,575.36
June 30, 1894, amount expended during fiscal year	1,575.36
Amount (estimated) required for completion of existing project	14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	14,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The river and bayou were reported navigable from December 1, 1893, to June 30, 1894.

List of stern-wheel steamboats engaged in navigation of Tensas River and Bayou Maçon during fiscal year 1894.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
Danube	232.32	175	33.8	5.1	2 0	5 6	New Orleans and Floyd	5
Marcus Collins	48.14	90	17	2.5	1 1	3 0	Trinity, Upper and Lower Tensas, and Choctaw Bayou.	35
Laura Blanks	62.73	104.8	21.3	3.8	1 1	4 0	Trinity and Floyd	20
							Trinity and Upper Tensas	12
							Trinity and Choctaw Bayou	4

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.	1888–'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	450	498	3,762	2,760	1,527	2,750
Cotton seed	1,400	1,457	4,876	4,850	2,920	4,000
Hides and skins	2	3	.....	10	2	5
Live stock	108	3	10	6	.....	225
Staves	895	26	71	1,032	3,325	3,500
Lumber	300	.....	440	.....	.....	.....
Miscellaneous	104	.....	1,942	378	50	1,823
Total down freight	3,259	1,987	11,101	9,036	7,824	12,303
Return freight	2,700	662	5,886	6,000	5,216	8,202
Total	5,959	2,649	16,987	15,036	13,040	20,505
Estimated value	$389,000	$122,500	$990,000	$999,500	$742,390	$1,194,100

NOTE.—The bottom lands were all overflowed last year; what business was done came from the hill lands.

The Vicksburg, Shreveport and Pacific Railroad crosses Bayou Maçon near Delhi, La. The New Orleans and Northwestern Railroad crosses Tensas River near Daniels Ferry, Concordia Parish, La.

V 8.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

Big Black River has its source in Webster County, Miss., flows in a general southwesterly direction, and enters Mississippi River at Grand Gulf, 37 miles below Vicksburg, having a length estimated to be about 400 miles.

Under river and harbor act of March 3, 1881, an examination of this stream was made, and the project submitted for its improvement contemplated two seasons' work in clearing a channel suitable for navigation at high stages of water by the removal of snags, logs, leaning timber, etc., from Cox Ferry to the mouth, about 130 miles, at an estimated cost of $32,000.

The following appropriations have been made:

By act of—	
July 5, 1884	$5,000
August 5, 1886	5,000
July 13, 1892	5,000
Total	15,000

The first appropriation was expended in 1884–'85, when a chopping party removed the principal obstructions for a distance of about 75 miles above the mouth.

The act of 1886 required that no part of the appropriation should be used until the State of Mississippi caused the bridges below the Vicksburg and Meridian Railroad to be so constructed as not to obstruct navigation. The bridges referred to were a county bridge at Baldwin Ferry, about 70 miles above the mouth; a county bridge at Ivanhoe Ferry, about 50 miles above the mouth, and the Louisville, New Orleans and Texas Railway bridge, about 15 miles above the mouth. The fixed railway bridge was changed to a swing bridge in 1889, in accordance with an act of the State legislature, the Ivanhoe bridge was replaced by a ferry in 1887, and the fixed wooden bridge at Baldwin Ferry was replaced in 1892 with a permanent iron swing bridge.

The river and harbor act of 1890 removed the restriction contained in the act of 1886 and authorized the expenditure of the appropriation. The project was modified to include only that part of the river below the Baldwin Ferry bridge, and in 1891 a snag boat and chopping party were employed on that stretch. The principal work done was between Baldwin and Ivanhoe ferries, a distance of about 20 miles.

No work was done during the fiscal year ending June 30, 1894. After operations in Yazoo River and tributaries were suspended preparations were made to organize a chopping party to begin at Baldwin Ferry and work downstream, but high water set in and prevented anything being done. This plan will be carried out when there is reasonable prospect of continued low water.

The following extract from my report of 1893 remains applicable this work, viz:

> In view of the small amount of commerce in this stream, the fact that there is ... bility of an increased business for years to come, and the cost of maintaining ... gation by the removal of snags and drift and leaning timber ... that any further amount can be expended profita...

Money statement.

July 1, 1893, balance unexpended	$5,085.93
June 30, 1894, amount expended during fiscal year	280.96
July 1, 1894, balance available	4,804.97

COMMERCIAL STATISTICS.

Big Black was reported navigable from January to the latter part of May during **the fiscal year.**

List of steamboats engaged in navigating Big Black River during fiscal year 1894.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
L. H. Sargent	Stern-wheel.	85.46	116.2	22.4	4.3	1 10	3 0	Vicksburg and Baldwin Ferry.	1
Joe	Tug	18.07	44.5	10	4	5 6	5 9	Vicksburg and Harris Landing.	

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton				13
Cotton seed	222	125		12
Lumber		30		2
Staves	946	2,238	1,499	471
Provisions	2	60		22
Grain				10
Saw logs	3,000	3,000	14,250	9,419
Total freight	4,170	5,453	15,749	9,979
Estimated value	$25,000	$22,900	$55,550	$72,000

The Alabama and Vicksburg Railway crosses Big Black on a fixed bridge 13 miles east of Vicksburg, and the Yazoo and Mississippi Valley Railroad crosses on a swing bridge about 15 miles above the mouth.

V 9.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 173 miles long, is formed by the junction of Tallahatchee and Yallabusha rivers, in Leflore County, Miss., flows in a general southerly and then southwesterly direction, and enters Mississippi River 5 miles above Vicksburg.

An examination, with a view to the removal of wrecks of gunboats, steamers, and other obstructions placed in this river during the war, was ordered by the river and harbor act of June 10, 1872, and was reported upon the following year (Report Chief of Engineers, 1873,

pp. 483, 484). A further examination was made in 1874, and estimates were submitted for thoroughly clearing the river of obstructions within a period of four years, at a cost of $120,000; a small annual appropriation to be made thereafter for maintenance of improvement (Reports Chief of Engineers, 1874, Part I, pp. 364–367, and 1875, Part I, p. 522). In view of the appropriations made, this plan could not be carried out, and in 1875 the present project was adopted, which contemplates the removal of wrecks, snags, logs, and leaning timber obstructing navigation the entire length of the river as far as practicable with the funds provided. New obstructions, caused by floods, sliding and caving banks, etc., are added from time to time, and the work should be gone over every year in the interest of safe navigation.

The following appropriations have been made:

By act of—		By act of—	
March 3, 1873	$40,000	July 5, 1884	$10,000
March 3, 1875	12,000	August 5, 1886	15,000
August 14, 1876	15,000	August 11, 1888	32,000
June 18, 1878	25,000	September 19, 1890	25,000
March 3, 1879	15,000	July 13, 1892	20,000
June 14, 1880	12,000		
March 3, 1881	6,000	Total	235,000
August 2, 1882	8,000		

The first appropriation was applied in 1873–'74 to the removal of the wrecks of nine vessels, sunk during the war, viz: The *Arcadia*, *R. J. Lackland*, *Golden Age*, *Glyde*, *Petrel*, *Ivy*, *Van Dorn*, *Polk*, and *Idaho*. After newspaper advertisement of fifty days only two proposals were received, and the contract was let to the lowest bidder for the aggregate sum of $35,450. Experience gained by this work showed that the improvement could be continued much more economically by the means of a snag boat operated with hired labor, and in 1875 and 1877 the U. S. snag boat *O. G. Wagner* was employed in removing wrecks and other obstructions. In 1879 the snag boat *John R. Meigs* was built, and the principal work since has been done with that boat. The benefits to navigation resulting from the work are marked; the large number of wrecks that obstructed the river and limited the period of navigation, many of which were sunk to prevent passage during the war, had been removed so as to present little or no obstructions, and the removal of snags, logs, leaning timber, etc., was carried on whenever funds were available for the purpose, giving steamboat navigation from head to mouth at all stages the year round. The total amount expended to June 30, 1893, was $223,578.40 (including $19.82 outstanding liabilities), part of which had been applied to building the snag boat *Meigs*, the purchase of a pumping dredge under the act of 1888, and to the survey of the mouth and lower river in 1890.

During the fiscal year ending June 30, 1894, operations were continued by the U. S. snag boat *Meigs*, P. R. Starr, master, as follows:

In July and August, 1893, needed repairs of the snag boat were made preparatory to resuming work during the low-water season and consisted of repairing wheel, painting steel hull inside and out, outside of cabin, engine-room, and wheel; building new stairway from main to boiler deck and new bulkheads around coal bunks; repairing railings; calking and repairing wooden decks; putting 17 new tubes in boilers, and replacing worn-out wooden deck under and around boilers with a new iron deck. Having completed the repairs, a crew was hired and the boat left Vicksburg the morning of August 23. The mouth of Yazoo was obstructed by the bar, which forms at low stages, and the *Meigs* grounded in attempting an entrance. After an hour's delay it succeeded in getting off and went to the relief of the steamer *John F.*

which had been in the Mississippi above the mouth about thirty-
urs, putting off freight to lighten sufficiently to pass over the
d had asked aid to prevent its barge from sinking. The barge
king badly, but the *Meigs* pumped it out in little more than an
fter which it backed up over the bar for a distance of about a
nding the channel full of lumps, with varying depths of from 1
et. From the mouth snagging operations were carried upstream
Tallahatchee River, which was reached September 13. Septem-
-26 the boat was transferred for temporary service in Talla-
e River, but returned to the Yazoo September 27, after which it
l over the river from head to mouth, removing all obstructions
uld be found, and returned to Vicksburg December 5, by which
iny weather had set in, preventing further work to advantage.
master of the *Meigs* reported that in the past season there were
liding banks than at any time since 1884, and below Yazoo City
nd stumps had slid into the channel until there was barely room
snag boat to pass. Tree slides had to be removed every few
the following places being mentioned as of special importance,
elow Yazoo and Mississippi Valley Railroad bridge, Deer Creek,
, Cottonwood, Browns Bar, the Narrows, below Lake Dick,
ia, Hopewell, Annadale, below Satartia, Enola, Gandercleugh,
alley, Alterra, Bee Lake, Fort Place, Roseneath, J. C. Martin's,
Millport, Riverside, Dew Drop, Hope On, Point Hatteras, Famosa,
lls, bend below Random Shot, Just Over, Idlewild, Huntsfield,
Shade, Cary Middleton, Diamond G, Hunters Rest, Scotch
Eagle Bend, Fair Play, Alligator Bayou, Sedge Field, Scotts
and at numerous other places of minor importance. Within a
e of one-half mile, near Random Shot, 52 snags, logs, and
were taken from the channel; near Famosa 35 snags and stumps.
moved; along Cottonwood Bar 51 snags, trees, and stumps were
out; 41 snags and stumps were removed near Enola; and at
Bar, just above Yazoo City, 12 trees nearly buried in the mud
moved, and the resulting scour gave an immediate increase of
t depth on that crossing. A good low-water channel was secured
laces worked over, the removal of obstructions causing the bot-
scour at many places heretofore shoal at low stages. November
wreck of the steamer *Ike Bonham* (sunk August 9, 1893, at
Horn) was removed with exception of the boiler and doctor
, which were in 22 feet of water. The brush dam built at McCor-
Bar in October, 1892, having given much relief at that cross-
supplementary dam was built November 28–29, about 400 feet
the old one, and steamboat men report that it has proven a suc-

following is a summary of the work done by the *Meigs* in Yazoo
August 23 to December 5, 1893, viz:

lled	610
pulled	329
noved from channel	136
ags cut	901
umps cut or destroyed with explosives	1,514
trees cut	16,183
trees topped	454
rdled	7,867
ards brush and willows cut	785
eet brush dam built	225

emoved, viz: Steamer *Ike Bonham* at Cape Horn.

work, performed at the lowest stages of water, put the river in
avigable condition, and has received the commendation of the

steamboat men, but, as snags and tree slides are brought into the stream by each high water, it should be continued for many years.

After return to Vicksburg, the crew of the *Meigs* was discharged, with the exception of such employés as were required for the proper care of the boat and to make essential minor repairs. It was laid up at the river landing at Kleinston until January 17, when, the water having risen sufficiently for it to go through West Pass, it was moved into Lake Centennial, in order to consolidate all the plant at Vicksburg and reduce the cost of care and repairs. After entering the lake the *Meigs* recovered from 30 feet of water the boiler, engine, and fly wheel of the pumping dredge, wrecked during a severe wind storm March 3, 1893, being all the parts of the lost machinery that could be located in the soft mud.

As the greater portion of the balance available was allotted by the act of 1888 for the pumping dredge, nothing further can be done for the general improvement of the river until a new appropriation is made.

Work in Yazoo and tributary streams could be carried on more economically if they were grouped together as a system and appropriations made under one head, with allotments for each stream. The plant could then be bought from the general appropriation and its use charged pro rata without being a heavy burden upon any one stream. A modern dredge, preferably self-propelling, would be of great use in parts of Yazoo, Tchula Lake, and Big Sunflower, but the largest appropriation of late years for any one of the streams mentioned would not be sufficient for the purpose. So also with regard to pile-drivers, quarter boats, or small hand-snagging outfits, the idea being to have a district plant to be used on any of the streams of the system when needed. The estimates are made with this view, the work required not being of a kind that can be done advantageously or satisfactorily by contract. A great deal of work remains to be done in clearing the banks of leaning timber to prevent tree slides and snags, and to make the passage of the sharp bends safer, and this can be done most economically by shore parties housed and subsisted on quarter boats, leaving the heavy work to be done at the proper or convenient time by the snag boats. There are also many places where the channel is injured by dispersion, and where chutes should be closed or wing dams built. As Yazoo and tributaries are not subject to heavy drift, work of the kind need not be expensive, and probably sheet piling would answer very well.

DETAILED ESTIMATES.

General service plant:		
Dredge	$30,000	
Pile-driver	4,000	
Quarter boats	2,500	
Skiffs, tools, rigging, etc	3,500	
		$40,000
Service of plant:		
Expenses of snag boats	24,000	
Expenses of dredges	9,000	
Expenses of shore parties	7,000	
		40,000
Care of plant:		
New boilers	4,000	
Hull repairs	3,000	
General and extraordinary repairs	1,500	
Fleet, wages, supplies, etc	1,500	
		10,000
Surveys:		
Local surveys, gauges, discharge measurements, etc	6,000	
		6,000
Administration:		
Office expenses, rent, supplies, etc	1,500	
Assistant engineers, draftsmen, transportation, and incidentals	2,500	
		4,000
Total		100,000

Money statement.

July 1, 1893, balance unexpended	$11,441.42
June 30, 1894, amount expended during fiscal year	8,978.29
July 1, 1894, balance unexpended	2,463.13
July 1, 1894, outstanding liabilities	14.50
July 1, 1894, balance available	2,448.63
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	100,000.00

COMMERCIAL STATISTICS.

The river was reported closed to navigation by the bar at the mouth from August 20 to September 25, 1893. Above the mouth it was navigable its entire length the whole year.

List of steamboats that navigated Yazoo River in fiscal year 1894.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
John F. Allen	Stern-wheel.	133.90	130.2	24	4.2	1 8	4 0	Vicksburg, Yazoo City, and Greenwood.	31	42
Birdie Bailey	..do...	109.70	111	22	3.5	1 10	4 0	Yazoo City, mouth, and Belzona.	232	2,400
Addie E. Faison	..do...	241.50	135	30.6	4.9	2 2	5 0	Vicksburg and Greenwood.	7	20
Blanks Cornwell	..do...	232.40	140	29	4.6	2 2	5 2	....do	41	510
Ike Bonham	..do...	78.52	93.4	18	3.6	1 8	3 6	Yazoo City and Greenwood.	6	3
Hibernia	..do...	157.06	135	25	4	2 6	5 0	Yazoo City, mouth, and Belzona.	44	440
Thos. A. Hendricks*	..do...	81.86	108	22.5	4.2	.....	.....	Not reported	.....	.....
Dee Arc	..do...	40.88	95	18	3	1 4	3 0	Mouth and Greenwood.	5	1
L. H. Sargent	..do...	85.46	116.2	22.4	4.3	1 10	3 0	Vicksburg and Yazoo City.	12	.....
H. M. Townsend*	..do...	87.70	116.7	18	3.1	.....	.....	New Orleans and Tallahatchee River.	1	.....
Gamma†	..do...	44.32	84	18.4	4.3	2 6	3 6	Vicksburg and Tallahatchee River.	1	.....
Ferd R†	..do...	45.50	93	16	3	1 6	2 6	Yazoo City and Tokeba Bayou.	25	.....
								Yazoo City and Silver City.	15	.....
								Yazoo City and Sunflower River.	10	.....
								Yazoo City and Tallahatchee River.	4	.....
John M. Abbott†	..do...	97.78	92	20	3.6	.....	.....	Not reported	.....	.....
Crown Point	..do...	159.14	123	25	4.2	2 2	4 4	Vicksburg and Sunflower River.	1	.....
Uncle Billie	..do...	79.81	88	17.7	3.9	1 4	3 0	Local towing out of Greenwood.	.....	.....
Bertha C	Tug	.....	.....	.....	.....	.....	.....	....do	.....	.....
Joe Seay†	..do...	27.74	75	16	6	7 0	8 0	New Orleans and Yazoo River.	1	.....
								Vicksburg and Greenwood.	1	.....
								Vicksburg and Y. and M. V. R. R. bridge.	4	.....
								Vicksburg and Sunflower River.	2	.....
Joe†	..do...	18.07	44.5	10	4	5 6	5 9	Vicksburg and Crooks Point.	15	.....
								Vicksburg and Y. and M. V. R. R. bridge.	25	.....
J. B. O'Brien†	..do...	44.49	70.8	15.2	7	7 10	9 0	Mouth and Yazoo City.	3	.....

* Towboats. † With barges.

Summary of commerce reported.

Articles.	1893-'94.	1892-'93.	1891-'92.	1890-'91.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	15,815	11,094	15,653	13,750
Cotton seed	17,355	12,795	16 570	12,560
Hides and skins	10	26	19	10
Live stock	60	79	124	60
Lumber	3,200	3,122	3,318	3,000
Staves	14,447	12,488	6,864	1,350
Provisions	12,020	8,547	10,502	9,020
Grain	14,280	6,107	12,531	11,000
Saw logs	22,400	11,800	15,000	2,110
Miscellaneous	12,200	8,507	12,624	10,500
Total freights for Yazoo proper	111,787	74,565	93,205	64,050
Total freights from tributaries	136,394	124,887	116,021	97,588
Total freights, Yazoo and tributaries	248,181	199,452	209,226	161,638
Estimated value	$8,314,000	$4,329,000	$7,351,500	$6,315,275

The Georgia Pacific division of the Richmond and Danville Railroad crosses Yazoo River at Fort Loring, 5 miles below Greenwood, and the Yazoo and Mississippi Valley Railroad crosses about 15 miles above the mouth. The latter has a branch from Clarksdale to Minter City, on the Tallahatchee, which will be extended down the stream to Greenwood. The Yazoo branch of the Illinois Central Railroad from Parsons on the Yallabusha to Jackson, Miss., runs parallel to the river, touching at Greenwood, Sidon, Tchula, and Yazoo City, and has a tap line from Tchula to the main line at Durant.

V 10.

IMPROVEMENT OF MOUTH OF YAZOO RIVER, MISSISSIPPI.

The shifting bar at the mouth of Yazoo River is the most serious obstruction to commerce, and boats that could navigate the principal streams of the Yazoo Valley system (about 800 miles) without hindrance are prevented at low stages from entering or leaving without lightering, and frequently navigation across the bar is closed altogether.

The river and harbor act of 1890 directed that a survey be made from the Louisville, New Orleans and Texas Railway (now Yazoo and Mississippi Valley Railroad) bridge to the mouth, to determine in what manner the mouth could be improved to permit free passage of vessels at all seasons of the year, and to include an investigation of the feasibility and advantage of making a new outlet for the river by way of Chickasaw Bayou or otherwise, with an estimate of cost.

The report and maps of this survey were submitted February 4, 1892, and the report was reprinted in Report of Chief of Engineers, 1892, pp. 1627-1642. The improvement proposed contemplates the formation of a new outlet from the former mouth of the Yazoo, on Old River, through the deep water in Old River, across the lowlands between Long and Barnett lakes to Lake Centennial, around the head of De Soto Island, along the front of Vicksburg, and entering Mississippi River on the channel side at Kleinston. The cost of the work required was estimated at $1,500,000.

The river and harbor act of July 13, 1892, provided an appropriation of $75,000 for commencing the improvement in accordance with the foregoing project, to include borings and gaugings and obtaining the right of way, and appears to have been based upon the first item of my estimates, p. 1630, report of 1892, viz, "Cost of right of way, 500 *acres, more* or less, clearing, grubbing, etc., $75,000."

ıe details of operations during the fiscal year will be found in the ort of Assistant Engineer Marshall herewith.

he completion of the line of precise levels has been of value to this k in itself, and a great gain to that part of the district lying in the zoo Delta. Incidentally high and low water elevations of the tribu- y streams between Mississippi River and the Yazoo have been tained by the line from Greenville, Miss., to Greenwood, and we have finite values of the fall of Yazoo River at extreme stages between eenwood and the mouth, a distance estimated by rivermen at about 2 miles, and by map 177 miles. The levels were continued from eenwood down the Louisiana division of the Illinois Central Rail- ad to Yazoo City, where they joined the line already run from the ast Survey bench at Delta Point, opposite Vicksburg. Permanent nches were set about 1 meter under ground at suitable points, or ade at the permanent bridges across the streams on the line, as own on the sketches accompanying Table 1, which gives the eleva- ns.

The plane of reference is still the Cairo datum, adopted before the line precise levels along Mississippi River had been completed between iro and the gulf, and which to insure being below gulf level was umed at a certain distance below the zero of the gauge of the Delta veys of 1857–1859, viz, 300 feet below the reading 9.16 feet on the sent engineer gauge at Cairo. The Mississippi River Commission blished a "provisional elevation" of mean gulf level some years ago 21.26 feet above the Cairo datum, while the U. S. Coast and Geodetic rvey have referred all of their levels from Biloxi up Mississippi and kansas rivers, and from Biloxi to Mobile and thence to Cairo and St. uis up the Mobile and Ohio Railroad and connections, to an adopted an gulf level, viz, the mean result of observations corresponding to 3 feet on the tide gauge in Biloxi Bay, which is 0.3005 meter below eir bench F_1 on a pier of the Louisville and Nashville Railway bridge. is is also bench No. 21 of the Mississippi River Commission. The esent difference within this district between the Cairo datum and ast Survey mean gulf level is 6.3613 meters or 20.87 feet, which must used in passing from one system of levels to the other.

The precise levels of Red River survey, Ouachita River, and those ven with this report comfirm the excellence of the original Coast rvey line from Biloxi to Greenville, but until the discrepancies which pear between Greenville, Cairo, and St. Louis are adjusted, it will be st to use the arbitrary plane of Cairo datum.

The cost of the precise leveling was kept below the usual rate by actical help from the railway companies whose lines they followed. and cars were supplied with experienced men, and transportation rnished by the Illinois Central Railroad over the Valley and Louisana vision, by the Georgia Pacific, and the Vicksburg and Meridian llways, the only charge being for the wages of the men sent with the nd cars. In return for this assistance the results of the levels were rnished the several companies interested, which, with the permanent rks left, will enable them to correct their profiles and grades at any ne without releveling over long distances.

This district is much indebted also to the Coast Survey for reports d special information at various times, and for careful work in com- ring and testing the rods which were sent with the levels made by rn, of Aarau, Switzerland.

To furnish a base for future level work on the west side of the dged channel in front of Vicksburg, iron and vitrified pipes and

marking points have been set at intervals and connected with the system of levels, definite reference points having been already established on the city side, for it was believed by many that the reduction in depth of the channel or canal was due to deposit from Mississippi River during high water. Doubtless a portion of the fill in successive years after dredging operations had ceased was due to silting, but it is my opinion that the soft material on the sides of the cut ran in, and also forced the bottom up as the weight was removed, not only by dredging, but by the withdrawal of the water as the river fell. Changes in elevations of the pipes will show this, while the fill or scour may be determined from the fixed points on the Vicksburg front beyond the influence of the canal.

This canal can not be kept open by dredging alone, except by continuous work and at great cost, and therefore the excavation between Old River and Lake Centennial should be hastened by giving the full amount of the appropriation in order to turn Yazoo River and carry it along Vicksburg front in the shortest possible time, to secure the advantage of a downstream current in the canal.

The maps have been finished on scale 1:5000, and a final line selected for the excavation between Old River and Lake Centennial, and borings made at intervals extending below the grade of the bottom of the proposed cut, and the character of material determined. It appears to be the same as that through which Yazoo River flows, and I have little doubt that the new route would change no more than do the present river banks, except, perhaps, for a short distance where the line crosses an old river bed near Barnett Lake. Here soft mud is found at the full depth, and it may become necessary to make the cut much wider than intended, or perhaps shift the line somewhat to the northward to avoid it. The change, however, would make no material difference in the final cost of the work.

On all accounts it was thought best to have an ample right of way, not only to give room for filling in with part of the spoil, but to allow for levee construction, if required, at a safe distance from the edges of the cut. The cost of the lands required would be enhanced considerably if too small a width were taken in the first instance and more should have to be bought after the work were established. One thousand meters was thought to be the least width prudent to allow also for enlargement, and this will require about 1,200 acres, more or less, for which an estimate of $30,000 was made.

The act approved July 13, 1892, provided as follows:

* * * And should the Secretary of War be unable to obtain such right of way as may be necessary in the prosecution of this work, upon reasonable terms, by agreement, purchase, or voluntary conveyance, he is hereby authorized to apply at any term of the circuit or district court of the United States for the western division of the southern district of Mississippi, and in the name of the United States institute and carry on proceedings to condemn such lands as may be necessary for right of way as aforesaid, and in such proceedings said court shall be governed by the laws of the State of Mississippi so far as the same may be applicable to the subject of condemning private property for public use.

I considered my duty limited to the engineering questions, and desired to have commissioners or an expert appointed to appraise the lands, who should be paid for their services, according to section 404, Digest of Decisions of Second Comptroller, vol. 3, which reads as follows:

Under an act which provides for the procurement of land, or right pertaining thereto, needed for the site, location, construction, or prosecution of works for fortifications and coast defenses, the Secretary of War is not restricted to any particular method of acquiring the same, but can, at his discretion, engage the services of an

m the tax lists; but as the taxes, if paid, seem to have been paid with deductions at times on account of overflows, they offered for estimates. From the best information attainable, although d or third hand, the offers were generally much in excess of s paid at the time of latest transfers. Another effort will be ortly, and, if not more successful, request will be made for ient of an expert familiar with the subject, in accordance with ion of the Second Comptroller already quoted, or application urts recommended.

nds covering the proposed right of way are overflowed to a or less extent every year. The zero of the Vicksburg (Klein- ige is 20.13 meters (66.04 feet) above Cairo datum, and the the flood heights from 1872 to 1894 inclusive is 43.77 feet on e, or 33.47 meters (109.81 feet), Cairo datum. The whole of the ontaining the required lands has been completely submerged nes since 1872; in four other years communication with the oints on Old River was possible during high water only by nd in every year since 1872, except 1889, all of the right of way ie higher ground between Old River and Barnett Lake has been from 4 to 14 feet or more. The only part now valuable for agri- ies on Old River, upon which crops may be raised if the river rise above 45 feet on the Vicksburg gauge or if high water rly in the season and remains up but a short time. The high- ever recorded at Vicksburg was 51.10 feet on the gauge in en the levees were down, and the highest since 1872 was 49.05 890. The least high water was 34.43 feet on the gauge in 1889. tal amount of land required for a width of 1,000 meters, more nd a length along the middle line from low water in Old River ater in Lake Centennial, is about 1,200 acres, as stated, esti- follows:

	Acres.
.....	87
.....	25.81
.....	647.94
nd batture.....	390.20

tion might be done by contract for less than $1,000,000 under the method of "continuing contracts," but hardly in any other way, because not less than 10,000 cubic meters a day should be demanded, which should be exceeded if possible, and this would require not less than five dredges of large capacity, with attendant plant, working night and day, except Sundays, to finish in the time estimated for doing the work with plant owned by the United States. The chief advantages of the latter method are that the profits are put into the work itself; that there are no charges for insurance, demurrage, bank accommodations, etc., and small room for discontent and labor troubles on account of long hours, etc. Besides, after the plant is once at the scene of operations, it can be shifted from point to point, according to the stage of water or the exigencies of the work, without friction or delays. Finally, the excavation may be increased or reduced as the state of the work may indicate during progress or the stability or instability of the banks may be demonstrated. The dams and revetment work can not be put under contract advantageously, and since it may be possible to omit a considerable portion of this class of work—and I have great hope that such will prove to be the case—this amount should be kept in reserve, to be expended as estimated later on if required, or applied to enlargement of the canal, especially in the harbor of Vicksburg.

On conclusion of the work, the plant could be disposed of most advantageously to other works under the Department.

If the negotiations for the lands have a successful termination without recourse to the courts, the limits of each piece of property will be laid out on the maps, and operations begun to clear the right of way and to remove all stumps, logs, etc., from about 250 meters on each side of the middle line. Range stones will then be planted on each side at intervals of about 100 meters and connected with the level system, to furnish basis for measuring the excavation as it progresses.

The question of jurisdiction will require no action on the part of Congress or of the Secretary of War, the act in the Code of Mississippi in regard to cession for public purposes having been amended at the recent session of the State legislature so as to include any lands acquired by the United States for public works. The funds on hand are ample for the purchase of the lands and all expenses incident thereto—clearing the right of way, grubbing, and the necessary surveys.

Money statement.

July 1, 1893, balance unexpended		$65,580.85
June 30, 1894, amount expended during fiscal year		4,496.06
July 1, 1894, balance unexpended		61,084.79
July 1, 1894, outstanding liabilities		2.00
July 1, 1894, balance available		61,082.79
Amount appropriated by act of August 17, 1894:		
For the cut	$225,000.00	
For Vicksburg Harbor	40,000.00	
		265,000.00
Amount available for fiscal year ending June 30, 1895		326,082.79
Amount (estimated) required for completion of existing project		860,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		860,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

of 1 meter on Red River survey, precise level rod No. 3, under varying con-
of humidity and temperature. The determinations made in June of the
year are by the U. S. Coast and Geodetic Survey, and the length given is
d of the total length of the rod as measured by them. The rod is nominally
s long, and to avoid endless computation it is necessary to assume that the
ce of elevation between two benches is the result of measuring with a rod
ength is the mean of the lengths of the 3 meters. The detail determination
he bottom, middle, and top meter to be less than a meter in length by 0.345,
nd 0.263 of millimeter, respectively.
sult given under date September 21, 1892, was obtained at this office by com-
with rod IV of Mississippi River Commission and Lake surveys, by direct obser-
with the level, the rods being held alternately on supports which differed in ele-
bout the full length of the rod. The lengths of the meter on rods heretofore
work under this office have been ascertained in a like way, and the error is
y no greater than in this instance. The difference of elevation between
ought now, in strictness, to be reduced 0.038 millimeter per meter, but this
ntity too small to appear between successive benches, and even between
ide apart it would be of little consideration in the presence of the uncom-
d error due to the distance run, hence no change will be made.
istance by level route from U. S. Coast and Geodetic bench at Delta, La., to
ity, Miss., was 104 kilometers, and from U. S. Coast and Geodetic bench at
lle, Miss., to the same place 170.4 kilometers. The elevation at Yazoo City,
d from the two directions, differed by 73.5 millimeters. This has been dis-
las a correction over the two stretches in proportion to the distance, minus
ne, and plus 45.6 to the other. Each bench was corrected by the amount
oned to its distance from the initial Coast Survey bench. This was in effect,
he Coast Survey line as absolutely correct between Delta and Greenville, a
of 188.85 kilometers. What part of the error is justly theirs can be approx-
nly when they close their loop, Vicksburg, Memphis, Corinth, Meridian.
2 gives elevations of high water at several points, and Table 3 gives those for
er. The obliteration of slope near the mouth at time of high water and the
ration at low water is the most noteworthy feature of the tables.
4 gives the elevation of gauge zeros.
g the fiscal year field work was confined to making eleven borings along the
he proposed diversion canal, and measuring and marking a reference base on
ow bar along the western side of the canal in front of Vicksburg. Repeated
ments from this base, it is hoped, will determine whether the fill in the canal
silting, sloughing, or settling of the banks. The boring was done by driv-
ich wrought-iron pipes into the ground, with the lower end open, and when
ame plugged pulling them up and inserting other pipes in the same holes.
er surface in Old River and Lake Centennial was about 25 to 28 meters
airo datum while the boring was going on, and the material was invariably
l or thoroughly saturated with water when brought up in the pipes from
at elevation or below.

buckle served to fasten them all together. The following table gives the ch
istic measurements of the gauze:

Sieve.		Thickness of wire.		Width of mesh.		
					Piece furnished by—	
No. mesh.	No. wire.	Test sample.	Piece furnished.	Test sample.	Measure.	Computation.
		Mms.	*Mms.*	*Mms.*	*Mms.*	*Mms.*
90	39	0.128	0.126	0.176	0.155	0.152
30	31	(*)	.346	(*)	.598	.542
16	26	.483	.493	1.052	1.090	1.080
12	24	.582	.592	1.525	1.553	1.525
10	23	.667	.680	1.949	2.039	1.975

* No test samples sent, and 30 mesh, 32 wire was asked for to get 0.5 millimeter ope

"Test samples" were gotten to select from.

The meaning of the columns is plain except, perhaps, that headed com
which is useful only as a test of the accuracy of the others. This was de
counting the meshes in a measured length, dividing the distance by the nu
subtracting the thickness of the wire. The means adopted for measuring
and meshes consisted of a slow motion screw and clamp off an instrument
carry an eye-piece, borrowed from the same source, over the face of th
while with the same movement it carried a piece of isinglass having a
marked on it behind the gauze. It was an improvised filar micrometer,
screw was rated by running over a small scale. The results show the m
measuring was accurate enough to prove the sieves sufficiently regular
classify the material by diameter of particles within small limits. Quite
as can be determined, the other two factors, specific gravity and upward
which enter into the question of transporting by flowing water; or the
the stability of the banks. A sample from a boring was taken from co
joints of like appearance, and after weighing was placed in the top box
shaken. The portions remaining in the separate compartments were then
and the per cent of each calculated. By means of a float carrying a pan a
below the water, an approximation was made to the specific gravity of the
in each box, in which there remained a sufficient quantity, to wit, about 7 g
bucket of clear cistern water at about 70° F. was used for the determinatio
method was adopted in testing for specific gravity because the question of
amount of moisture does not enter in, and the result is a measure of densi
particles which is a prime factor in floating. It is proposed to test the ma
angle of repose, and scour under the action of currents of water.

The locations and principal features of the borings are shown on the pro
mitted; the characteristics are given in detail in Table 5. The diameters
to tenths of a millimeter, and the figures express sensibly the size of particle
will pass through the sieves. In other words, the tests were made as accu
circumstances would permit, and then decimals in doubt were discarded.

Very respectfully, your obedient servant,

H. M. MARSHAL
Assistant En

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

ompany My Report for Fiscal Y

Captain

Growth of Willows

nd Bar

TABLE NO. 1.—PRECISE LEVELS.

[Observers: T. G. Rombauer, R. S. Buck, jr., and Walter H. Polk.]

Instrumental constants.

TABLE A.

Kern level.	Pivot correction for a distance of 1 meter.	Date of determination.
	Millimeter.	
L. S. No. 1	+0.010	Feb. 16, 1889.
L. S. No. 1	+ .018	June 4, 1889.
L. S. No. 1	+ .021	Oct. 17, 1889.
M. R. C. No. 1	— .016	Feb. 16, 1889.
M. R. C. No. 1	— .006	Oct. 17, 1889.
M. R. C. No. 2	+ .014	May 29, 1889.
M. R. C. No. 2	+ .002	Dec. 28, 1889.
M. R. C. No. 2	— .002	Oct. 22, 23, 1890.
R. R. S. No. 1	+ .007	Sept. 19, 20, 1892.
R. R. S. No. 1	+ .007	June 6, 1893.
R. R. S. No. 2	— .008	Sept. 13, 1892.

TABLE B.

Bubble tube.	Value one division for a distance of 1 meter.	Date of determination.
	Millimeter.	
L. S. No. 4	0.016	Feb. 16, 1889.
L. S. No. 4	.016	June 4, 1889.
L. S. No. 4	.022	Oct. 18, 1889.
M. R. C. No. 1	.013	Feb. 16, 1889.
M. R. C. No. 1	.008	July 5, 1889.
M. R. C. No. 1	.014	Oct. 18, 1889.
M. R. C. No. 2	.015	June 4, 1889.
M. R. C. No. 2	.021	Dec. 28, 1889.
M. R. C. No. 2	.015	Oct. 22, 23, 1890.
R. R. S. No. 1	.017	Sept. 19, 1892.
R. R. S. No. 1	.019	June 6, 1893.
R. R. S. No. 2	.016	Sept. 13, 1892.

TABLE C.

Rod.	Length of 1 meter on rod.	Correction for spur.
	Millimeters.	*Millimeters.*
II	*999.866	+47.5
IV	*999.890	+48.2
R. R. S. No. 5	999.770	—51.5
R. R. S. No. 6	999.839	—51.3

*ean of Lake Survey and Mississippi River Commission determination. See Mississippi River Commission Report, 1881, p. 5].

TABLE NO. 1.—PRECISE LEVELS—Continued.

TABLE D.

Length of Red River survey, precise-level rod No. 3.

Date.	Relative humidity.	Length of 1 meter on rod.	Temperature.
	Per cent.	*Millimeters.*	*Degrees, C.*
June 9, 1894..	68	999.746	19.00
June 11, 1894..	Not noted.	999.799	21.20
June 13, 1894..	70	999.817	22.70
June 14, 1894..	61	999.803	22.10
June 14, 1894..	61	999.791	21.00
Means ...	65	999.791	21.20
June 16, 1894..	52	999.784	29.20
June 16, 1894..	52	999.760	29.75
June 18, 1894..	46	999.680	33.96
June 18, 1894..	47	999.674	34.65
June 19, 1894..	39	999.683	35.45
June 21, 1894..	33	999.009	37.45
Means ...	45	999.698	33.41
June 23, 1894..	(*)	999.817	27.35
June 29, 1894..	.....	999.813	26.85
Means ...	.....	999.815	27.10
Sept. 21, 1892..	† 54	999.706	29.40

* During previous three days rod had been in a vault where the relative humidity was 90 per cen
† Interpolated from U. S. Weather Bureau record.

Tabulated results.

FROM DELTA, LA., TO KLEINSTON, MISS.

[Observer, R.]

Bench.	Distance—		Difference of elevation.		
	Between bench marks.	From Delta.	East.	West.	Mea
	Kilos.	*Kilos.*	*Meters.*	*Meters.*	*Meter*
C. and G. survey P. B. M. No. 215					
C. and G. survey SW. base			{—1.2435 {—1.2459	{—1.2496	—1.2
T. B. M. 1	2.6	2.6	+1.2095	+1.2101	+1.2
T. B. M. incline	.5	3.1	—5.3341	—5.3373	—5.3
Peg (*a*) Louisiana	.3	3.4	—3.3064	—3.3036	—3.3
Peg (*b*) Mississippi	1.6	5	.....	.....	*—.1
T. B. M. West Pass	.5	5.5	+3.1107	+3.1085	+3.1
Stone 1[7]	.9	6.4	+4.6131	+4.6229	+4.6

* River crossing, mean of 20 observations.

Tabulated results—Continued.

FROM KLEINSTON TO LOUISVILLE, NEW ORLEANS AND TEXAS RAILWAY (NOW YAZOO AND MISSISSIPPI VALLEY RAILROAD) BRIDGE.

[Observer, B.]

Bench.	Distance—		Difference of elevation.		
	Between bench marks.	From Kleinston.	North.	South.	Mean.
	Kilos.	*Kilos.*	*Meters.*	*Meters.*	*Meters.*
Stone 1[?]					
T. B. M. 1	1.5	1.5	+2.9887	+2.9924	+2.9905
2	1.8	3.3	+1.3797	+1.3838	+1.3817
3	1.7	5	+.1259	+.1211	+.1235
4	1	6	—.7572	—.7546	—.7559
5	1.8	7.8	—.8059	—.8011	—.8035
6	1.7	9.5	+.6558	+.6545	+.6551
7	1.5	11	—.3788	—.3830	—.3809
8	1.9	12.9	+1.1095	+1.1073	+1.1084
9	1.7	14.6	+2.9122	+2.9061	+2.9092
10	1.7	16.3	—3.2550	—3.2489	—3.2519
11	1.8	18.1	+.6647	+.6661	+.6654
P. B. M. 5	1.8	19.9	+.6227	+.6214	+.6220

FROM LOUISVILLE, NEW ORLEANS AND TEXAS RAILWAY (NOW YAZOO AND MISSISSIPPI VALLEY RAILROAD) BRIDGE TO YAZOO CITY AND GREENVILLE, MISS.

[Observer, P.]

P. B. M. 5					
T. B. M. 1	0.727	20.7	*—3.3354	—3.3353	—3.3354
2	.974	21.7	—.3611	*—.3630	—.3620
3	.872	22.6	+.6457	+.6455	+.6456
4	1.092	24.3	—.9860	—.9905	—.9886
5	1.538	25.8	+.4642	+.4586	+.4614
Rod Sta. 1	.546	26.3	—10.7389	—10.7383	—10.7386
2	.169	26.5	+.0399	+.0263	+.0331
T. B. M. 6	1.588	28.1	+10.6462	+10.6406	+10.6434
7	1.496	29.6	+2.9166	+2.9139	+2.9152
8	1.944	31.5	+4.1994	+4.1992	+4.1993
9	1.698	33.2	—2.3817	—2.3849	—2.3833
10	1.625	34.9	—1.2526	—1.2585	—1.2556
11	1.491	36.4	—.0102	—.0080	—.0091
12	1.681	38	—2.1153	—2.1095	—2.1124
13	1.285	39.3	—.3472	—.3526	—.3499
14	1.784	41.1	+5.0476	+5.0509	+5.0492
15	1.340	42.5	—5.2296	—5.2270	—5.2283
16	1.013	43.5	—5.0233	—5.0226	—5.0230
17	1.432	44.9	+2.9261	+2.9231	+2.9246
18	1.630	46.5	+.5245	+.5213	+.5229
19	1.675	48.2	—.4779	—.4803	—.4791
20	1.252	49.5	+.7031	+.7051	+.7041
21	1.123	50.6	+.3723	+.3772	+.3748
22	1.415	52	+.2062	†+.2947	+.2954
23	1.562	53.6	+.6579	+.6561	+.6570
24	1.308	54.9	+.2439	+.2449	+.2444
25	1.511	56.4	—.6011	—.6042	—.6026
26	1.516	57.9	+.6465	+.6456	+.6460
27	1.674	59.6	+.4004	+.4001	+.4018
28	1.586	61.1	—.4964	—.4974	—.4969
58	1.357	62.5	—.3713	—.3701	—.3707
57	1.539	64	+.6879	+.6850	+.6864
56	1.613	65.7	+.7236	+.7254	+.7245
55	1.548	67.2	+.4693	*+.4690	+.4692
54	1.397	68.6	—2.0013	—2.0066	—2.0040
53A	1.578	70.2	+.2281	+.2227	+.2254
53	.168	70.3	+.2437	+.2419	+.2428
52	.554	70.9	+.4911	+.4879	+.4895
51	1.466	72.4	+.1668	+.1679	+.1674
50	1.523	73.9	*—.2365	—.2391	—.2378
49	1.697	75.6	+.5212	+.5164	+.5188
48	1.514	77.1	—.0536	—.0541	—.0538
47	1.666	78.8	+.8028	+.7970	+.7999
46	1.672	80.4	—.3317	—.3361	—.3340
45	1.443	81.9	+.3530	*+.3552	+.3541
44	1.067	82.9	*+.2249	+.2237	+.2242
43	1.438	84.4	—.7594	—.7610	—.7602
42	1.776	86.2	+.1732	*+.1750	+.1741

*Mean of two determinations. †Mean of four determinations.

Tabulated results—Continued.

FROM LOUISVILLE, NEW ORLEANS AND TEXAS RAILWAY, ETC.—Continued.

Bench.	Distance— Between bench marks.	Distance— From Kleinston.	Difference of elevation. North.	Difference of elevation. South.	Difference of elevation. Mean.
	Kilos.	*Kilos.*	*Meters.*	*Meters.*	*Meters.*
T. B. M. 41	1.626	87.8	—.9010	—.9056	—.9033
40	1.447	89.2	+1.1268	+1.1291	+1.1280
39	2.030	91.3	—.4642	—.4593	—.4618
38	1.286	92.6	—.6687	—.6728	—.6708
37	1.506	94.1	+.8139	+.8081	+.8110
36	1.578	95.6	+.8710	+.8682	+.8696
35	1.510	97.1	*—.6425	—.6476	—.6450
34	1.218	98.4	—.4129	—.4147	—.4138
33	1.142	99.5	+.3430	+.3440	+.3435
32	1.717	101.2	+1.3841	+1.3835	+1.3838
31A	1.293	102.5	—4.4561	—4.4536	—4.4548
31	.158	102.7	+.3985	+.3903	+.3944
30	.920	103.6	+7.9065	+7.9080	+7.9072
P. B. M. 13	.398	104	—4.8607	—4.8613	—4.8610
T. B. M. 208	1.571	105.6	+1.8584	+1.8588	+1.8586
207	1.339	106.9	+3.6420	+3.6462	+3.6441
206	1.539	108.4	—4.9363	—4.9312	—4.9338
205	1.500	109.9	+2.2532	+2.2583	+2.2558
204	1.618	111.6	*— 1.5748	—1.5766	—1.5757
203	1.639	113.2	+.6196	+.6256	+.6226
202	1.652	114.9	+.4920	*+.4872	+.4896
201	1.587	116.4	+.2990	+.2975	+.2982
200	1.733	118.2	+.7411	+.7417	+.7414
199	1.671	119.8	—1.0331	—1.0314	—1.0322
198	1.346	121.2	+.1017	+.1029	+.1023
197	1.564	122.8	—1.1227	—1.1263	—1.1245
196	1.616	124.4	+.9132	+.9173	+.9152
195	1.604	126	—.1833	—.1857	—.1845
194	1.672	127.7	+.4017	+.3975	+.3996
193	1.734	129.4	+.9339	+.9337	+.9338
192	1.263	130.6	—.1666	*—.1606	—.1636
191	1.582	132.2	—.6330	—.6323	—.6326
190	1.520	133.8	—.2891	—.2850	—.2870
189	1.924	135.7	+2.0342	+2.0389	+2.0366
188	1.589	137.3	—1.1403	*—1.1360	—1.1382
187	1.558	138.8	+.4131	+.4244	+.4212
186	1.605	140.4	+.3833	+.3896	+.3864
185	1.600	142	+.3729	+.3771	+.3750
184	.812	142.8	—.3919	—.3903	—.3911
183	1.652	144.5	—.1214	†—.1171	—.1192
182	1.524	146	+.7084	+.7105	+.7094
181	1.558	147.6	+.2301	+.2423	+.2407
180	1.518	149.1	—.5580	—.5525	—.5552
179	1.290	150.4	+.5127	+.5098	+.5112
178	1.976	152.4	+.5950	+.5924	+.5937
177	1.246	153.6	—.2113	—.2084	—.2098
176	1.512	155.1	—.2460	—.2419	—.2440
175	1.588	156.7	+.4286	+.4300	+.4293
174	1.250	158	—.7281	—.7263	—.7272
173	1.744	160	+.4435	+.4432	+.4434
172	1.766	161.5	—1.0932	—1.0922	—1.0927
171	1.687	163.1	+1.5411	+1.5353	+1.5382
170	1.703	164.9	*+.1402	+.1391	+.1396
169	1.678	166.5	+.6003	+.6036	+.6020
168	1.886	168.4	+.3887	+.3836	+.3862
167	1.533	170	—.0763	—.0726	—.0744
166	1.040	171	+.0768	+.0752	+.0760
165	1.711	172.7	+.2691	+.2746	+.2718
164	1.630	174.4	+.0149	+.0184	+.0166
163	1.882	176.2	—.2868	—.2884	—.2876
162	1.442	177.7	+1.5836	+1.5841	+1.5838
161	1.803	179.5	—.1369	—.1412	—.1390
160	1.678	181.2	—.7107	—.7155	—.7131
159	1.608	182.8	+.4791	+.4821	+.4806
158	1.584	184.3	—.0334	—.0309	—.0322
157	1.729	186.1	—.2556	*—.2578	—.2567
156	1.592	187.7	+.0449	+.0491	+.0470
155	.879	188.5	+.2446	+.2476	+.2461
154	1.635	190.2	—.1972	—.1963	—.1968
153	1.612	191.8	+.7184	+.7187	+.7186
152	1.623	193.4	—.3583	—.3623	—.3603
P. B. M. 23	1.597	195	+1.6746	+1.6751	+1.6748
T. B. M. 151	.606	195.6	—1.7124	—1.7118	—1.7121
150	1.704	197.3	+.2823	+.2863	+.2843

* *Mean of two determinations.*

† Mean of four determinations.

Tabulated results—Continued.

FROM LOUISVILLE, NEW ORLEANS AND TEXAS RAILWAY, ETC.—Continued.

Bench.	Distance—		Difference of elevation.		
	Between bench marks.	From Klein-ston.	North.	South.	Mean.
	Kilos.	*Kilos.*	*Meters.*	*Meters.*	*Meters.*
T. B. M. 149	1.421	198.7	+.0074	+.0025	+.0050
148A	.610	199.4	*—.3761	*—.3776	—.3769
148	1.081	200.4	—.3121	—.3156	—.3138
147	1.651	202.1	—.3846	—.3870	—.3858
146	1.569	203.7	—.7591	—.7597	—.7594
145	1.710	205.4	+.5052	+.5007	+.5030
144	1.445	206.8	—.6946	—.6985	—.6966
143	1.638	208.4	—.8532	—.8540	—.8536
142	1.663	210.1	—1.2359	—1.2393	—1.2376
141	1.701	211.8	+.0475	+.0430	+.0452
140	1.741	213.6	—.5717	—.5779	—.5748
139	1.441	215	—.3421	*—.3384	*—.3402
138	1.779	216.8	+1.1519	+1.1456	+1.1488
137	1.664	218.4	—.5689	—.5676	—.5682
136	1.339	219.8	—.1529	—.1545	—.1537
135	1.728	221.5	+.5751	+.5698	+.5724
134	1.772	223.3	—.3832	—.3859	—.3846
133	1.593	224.9	+.5706	+.5702	+.5734
132	1.234	226.1	+.2932	+.2883	+.2908
131	1.766	227.9	+.2837	+.2772	+.2804
P. B. M. 18	1.450	229.3	+2.2227	+2.2204	+2.2216
T. B. M. 130	.329	229.6	+.2673	+.2690	+.2682
129	1.742	231.4	—3.0206	—3.0226	—3.0216
128	1.606	233	—.1527	—.1502	—.1514
127	1.662	234.7	+1.5772	+1.5706	+1.5739
126	1.545	236.2	+.1180	+.1200	+.1190
125	1.693	237.9	—.0498	*—.0459	—.0478
124	1.664	239.6	+.3581	+.3617	+.3599
123	1.608	241.2	+.6539	+.6493	+.6516
122	1.788	243	—.7985	—.7982	—.7984
121	1.341	244.3	—.7525	—.7518	—.7522
120	1.702	246	—.5208	—.5233	—.5220
119	1.610	247.6	—.1101	—.1156	—.1128
118	1.584	249.2	—.0605	—.0587	—.0596
117	1.674	250.9	—.1067	—.1128	—.1098
116	1.416	252.3	—.1105	*—.1094	—.1100
115	1.265	253.5	+.2263	+.2262	+.2262
114	1.691	255.2	+.1945	+.1972	+.1958
113	1.599	256.8	—.0547	—.0497	—.0522
112A	.785	257.6	+1.7081	+1.7038	+1.7060
112	.640	258.3	—.8087	—.8112	—.8100
111	1.489	259.8	+1.2111	+1.2062	+1.2086
110	1.498	261.3	+.4876	+.4871	+.4874
109	1.279	262.5	—1.1482	—1.1488	—1.1485
108	1.185	263.7	†—1.1291	—1.1271	—1.1281
107	1.684	265.4	—.2114	—.2131	—.2122
106	1.703	267.1	+1.7290	+1.7229	+1.7260
105	1.098	268.2	—1.0474	—1.0458	—1.0466
104	1.022	269.8	+.7823	+.7829	+.7826
103	1.358	271.2	+.4504	+.4477	+.4490
102	1.408	272.6	—.1527	—.1579	—.1553
101	1.528	274.1	+1.2099	+1.2071	+1.2085
Coast and Geodetic Survey, P. B. M. No. 1	1.272	275.4	+1.3833	+1.3808	+1.3820

* Mean of two determinations. † Mean of three determinations.

DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS FROM DELTA, LA., TO YAZOO CITY AND GREENVILLE, MISS.

NOTE.—All bench-mark monuments, when not otherwise described, consist of pieces of limestone 46 centimeters square and 15 centimeters thick, marked $\frac{\text{U. S.}}{\text{B. M.}}$ with spherical-headed copper bolts leaded in upper faces, and buried 1.2 meters under ground, access being given through 12-centimeter iron pipes set on top. Each pipe has a cast-iron cover, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and the letters $\frac{\text{U. S. E.}}{\text{B. M.}}$ raised on top. Elevations are expressed in meters above the Cairo datum and *apply to the* top of the bolt in the underground

stone. Elevation of boss of pipe can be found in any case by adding 1.24 meters to elevation of copper bolt.

C. and G. S. P. B. M. 215: For description see Report Chief of Engineers, 1885, p. 2676. Elevation, 34.084.

M. R. C. Stone Line Point $\frac{107}{1}$: Stone at Kleinston 110 meters from river bank, 9[illegible] meters east of sawmill, 56 meters east of narrow-gauge railroad, 60 meters north o railroad running down to cotton sheds on river bank, and on a line of broken leve extending back to high ground. It is 1,565 meters above oil mill and 1,178 meter below compress. Elevation, 33.013.

P. B. M. 1: Is crosscut in stone on east side of national cemetery gate, Vick burg, Miss., placed to hold gate when open. Elevation, 37.508.

P. B. M. 2: Is on east side of public road, about 3 kilometers above Vicksburg, W. H. Hundermark's store, 2.6 meters from northwest corner of yard, 16.4 mete from southwest corner of yard, and 31.92 meters from center of Yazoo and Mississip Valley Railroad track on approximate perpendicular to same. Elevation, 35.580.

P. B. M. 3: Is top of head of large spike driven in north side of brick smokestack gin on Blakely plantation, about 5 centimeters from ground. Elevation, 39.910.

P. B. M. 4: Is in northwest corner of cabin yard on left bank of Yazoo River, abo 130 meters southwest of south end of Yazoo and Mississippi Valley Railroad brid and 20 meters from top of river bank. Elevation, 34.853.

P. B. M. 5: Is crosscut and marked "U. S. B. M." on capstone of south end pier west side of Yazoo and Mississippi Railroad bridge. Elevation, 38.276.

P. B. M. 6: Is on left bank of Yazoo River, almost opposite mouth of Steele Bay in northeast corner of E. C. Cordwent's yard, Belle Isle plantation. Elevatio 34.536.

P. B. M. 7: At Calmar post-office, Warren County, Miss. Is in southeast corner garden attached to and on north side of post-office, rented (1892) by J. H. Adle and belonging to D. M. Legg's store and post office. It is about 1 kilometer soutl east of Adams Landing on Yazoo River. Elevation, 37.183.

P. B. M. 8: In Yazoo County, Miss., opposite L'Argent, 70 meters from left bank Yazoo River. Is in the west corner of calf lot across the public road from an belonging to cabin on Indian mound, which is opposite the mouth of Big Sunflowe River and on Gilruth's plantation. Elevation, 34.939.

P. B. M. 9: At L'Argent, Sharkey County, Miss. Is in the southeast corner of cot ton lot adjoining landing warehouse and about 25 meters from right top bank o Yazoo River. Is about 15 meters southwest of L'Argent store and 50 meters south east of gin. Elevation, 32.997.

P. B. M. 10: At Satartia, Yazoo County, Miss. Is in northeast corner of yard o union church and masonic lodge (Satartia Lodge, No. 176) at corner of Plum and Perry streets. Elevation, 35.768.

P. B. M. 11: At Enola, Yazoo County, Miss. Is in the northeast corner of yard t R. D. Saunder's dwelling, about 8 meters south of J. F. Powell's store and about 3 meters north of R. D. Saunder's store. Elevation, 36.420.

P. B. M. 12: At Yazoo City, Yazoo County, Miss. Is in north corner of yard t county court-house. Elevation, 41.887.

P. B. M. 13: At Yazoo City, Yazoo County, Miss. Is in north corner of yard t city public school building. School is near intersection of Washington and Main streets. Elevation, 37.345.

P. B. M. 29: At Bee Lake, Holmes County, Miss. Is at north corner of Illinois Central Railway depot. Elevation, 38.944.

P. B. M. 28: At Tchula, Holmes County, Miss. Is crosscut on top of southeast bolt holding roller to southeast pier of drawbridge over Tchula Lake. Elevation 40.086.

P. B. M. 27: At Tchula, Holmes County, Miss. Is in east corner of yard to Tchul section house belonging to the Illinois Central Railway. Elevation, 40.924.

P. B. M. 26: At Sidon, Leflore County, Miss. Is in northwest corner of yard t Sidon section house belonging to the Illinois Central Railway. It is about 35 mete south of the depot. Elevation, 43.358.

P. B. M. 25: At Greenwood, Leflore County, Miss. Is in north corner of yard Greenwood section house belonging to the Illinois Central Railway. It is about meters east of the depot. Elevation, 44.228.

P. B. M. 24: At Greenwood, Leflore County, Miss. Is in west corner of yard Leflore County court-house at corner of Front and Cotton streets. Elevation, 45.42

P. B. M. 23: At Fort Loring, Leflore County, Miss. Is cross cut in stone copi on the north end of the east pier supporting the Georgia Pacific Railway dra bridge over Yazoo River. It is at the northeast corner of the iron rest plate and

U. S.
marked ⋈ Elevation, 47.037.
P. B. M.

P. B. M. 22: At Fort Loring, Leflore County, Miss. Is in fence corner of fences dividing railway right of way, public road, and small garden, on McLemore and Baird's place. It is about 12 meters south of the Georgia Pacific Railway track and 6 meters west of the right top bank of Yazoo River. Elevation 45.178.

P. B. M. 21: At Itta Bena, Leflore County, Miss. Is in southeast corner of yard around Letulah school, and is about 2.5 meters from east fence and 1.5 meters from south fence. Elevation, 44.166.

P. B. M. 20: About 750 meters northwest of Baird, Sunflower County, Miss. Is about 18 meters east of the south end of the Georgia Pacific Railway approach to bridge over Sunflower River. It is in the northwest corner of yard belonging to house occupied by E. B. & G. B. Wade and owned by J. J. Oliver. Elevation, 41.778.

P. B. M. 19: On right bank of Sunflower River, Sunflower County, Miss. It is about 14 meters west of north end of Georgia Pacific Railway trestle approach to draw bridge over Sunflower River, and in southeast corner of yard to cabin occupied by Buck Willis on W. A. Pollock's plantation. Elevation, 41.050.

P. B. M. 18: About 1 kilometer northwest of Baird, Sunflower County, Miss. The point is marked by a cross cut on top of and on west end of south pier of the Georgia Pacific Railway bridge over Sunflower River. It is 0.80 meter from south edge of pier; 0.23 meter south of track on pier; 0.78 meter from west edge of pier; and 0.4 meter west of joint in stone. It is marked $\overset{\text{U. S.}}{\underset{\text{B. M.}}{\bowtie}}$ Elevation, 44.596.

P. B. M. 17: At Indianola, Sunflower County, Miss. Is in southwest corner of the grounds around the county court-house. Elevation, 41.862.

P. B. M. 16: At Heathman, Sunflower County, Miss. It is at west end of young bois d'arc hedge between board and wire fences in front of yard belonging to residence of J. A. Crawford. It is 2 meters northeast of northeast corner of his store and 5 meters south of the Georgia Pacific Railway track (main line). Elevation, 41.754.

P. B. M. 15: At "The Bogue," Washington County, Miss. It is in south corner of yard to cabin occupied by John Bailey (colored) on Bob. Ingram's place. It is about 1 meter from left top bank of Bogue Falaya; about 40 meters northwest of the Georgia Pacific Railway trestle across the Bogue. It is directly opposite the gin house on the right bank and about 75 meters southeast of the highway bridge. Elevation, 41.060.

P. B. M. 14: At Stoneville, Washington County, Miss. It is in the east corner of orchard belonging to house occupied by A. Jones and belonging to J. C. Greenley. Orchard is between house and grocery store belonging to Yuen Sing & Co. It is 0.7 meter from front fence and 0.4 meter from porch of store. Elevation, 43.348.

C. and G. S. P. B. M. 1: (Greenville.) (For description see Progress Report Mississippi River Commission, 1882, p. 2187.)

TABLE 2.—*High-water marks on Yazoo River, Mississippi.*

[Elevation in meters, Cairo datum.]

Locality.	1852.	1858.	1874.	1882.	1883.	1884.	1890.	1891.	1892.	1893.
Baird (Sunflower River)	.....	.....	.....	.....	.....	.....	40.59	.....	38.69	36.81
Greenwood	*46.13	*46.13	*46.40	46.76	46.45	45.61	44.96	45.73	45.90	.....
Fort Loring	.....	.....	.....	.....	.....	.....	.....	.....	45.27	42.63
Yazoo City	.....	.....	.....	39.50	.....	.....	37.23	37.26	36.80	36.25
Ebola	.....	.....	.....	.....	.....	.....	36.82	.....	.....	.....
Satartia	.....	.....	.....	38.69	.....	.....	36.63	35.93	.....	35.53
Lake Dick	.....	.....	.....	38.62	.....	.....	.....	.....	.....	.....
L'Argent	.....	.....	.....	.....	.....	.....	36.55	35.56	35.47	35.26
Y. & M. V. R. R. bridge	.....	.....	35.34	36.56	.....	36.26	35.96	35.31	35.28	35.33
Chickasaw Bayou	.....	.....	.....	.....	.....	.....	35.88	.....	35.27	35.33
One mile down Chickasaw Bayou.	.....	.....	.....	36.17	.....	35.87	35.09	35 16	35.21	.....
Mouth of Yazoo River	.....	.....	.....	.....	.....	.....	35.53	35.06	.....	†35.29
Vicksburg	.....	.....	34.06	34.98	33.48	35.06	35.08	34.76	34.88	34.85

*Information furnished by Mr. J. K. Allen, Greenwood, Miss., who has been living there since 1851.

†Two miles up Yazoo River.

TABLE 3.—*Low-water marks on Yazoo River, Mississippi.*

LOW-WATER MARKS OF 1891.

Locality.	Distance from Yazoo and Mississippi Valley R. R. bridge.	Elevation, Cairo datum.	Date.	Remarks.
	Kilos.	*Meters.*		
Yazoo City		27.93	Nov. 7, 8	
Yazoo and Mississippi Valley Railroad bridge.	0.0	21.93	Nov. 17	
Vicksburg	36.5	19.37	Nov. 16-18	

LOWEST ASCERTAINED WATER OF 1892.

Yazoo City		28.14	Oct. 30-Nov. 1	Lowest.
Yazoo and Mississippi Valley Railroad bridge.	0.0	21.95	Oct. 24	
Head of Old River	13.8	21.93	Oct. 26	
Do	13.8	21.89	Oct. 31	
Wrong End of Old River		21.89	Oct. 31	
Willow Bayou	24.8	21.10	Oct. 27	
2.6 kilometers above mouth of Yazoo River.	26.7	21.04	Oct. 28	
Mouth of Yazoo River	29	20.33	Oct. 28	
Mississippi River at mouth of Yazoo River.	29.3	20.11	Oct. 28	
Vicksburg	36.5	19.89	Oct. 28	
Do	36.5	19.82	Oct. 30	Lowest.

LOWEST ASCERTAINED WATER OF 1893 FROM GAUGE RECORDS.

Baird (Sunflower River)		31.33	Oct. 21	Record incomplete.
Fort Loring		34.80	Oct. 21	Do.
Yazoo City		28.21	Oct. 24-28	
Do		28.14	Nov. 3-9	Lowest.
Satartia		25.16	Oct. 24-28	Record incomplete.
L'Argent		24.32	Oct. 24-28	Do.
Vicksburg		20.25	Oct. 28, 29	Lowest.
Do		20.25	Nov. 18, 20	Lowest.

TABLE 4.—*Elevation of zeros of gauges on Yazoo River, Mississippi.*

Locality.	Established by—	Elevation, Cairo datum.
		Meters.
Baird (on Sunflower River)	U. S. Engineers	31.42
Fort Loring	do	34.71
Yazoo City	do	28.45
Do	U. S. Signal Service	27.13
Satartia	U. S. Engineers	25.47
L'Argent	do	24.11
Yazoo and Mississippi Valley Railroad bridge	do	Cairo datum.
Chickasaw Bayou	do	Do.
Head of Old River	do	Do.
Wrong End of Old River	do	Do.
Willow Bayou	do	Do.

BORING AT STATION 15; ELEVATION, 31.91 METERS, CAIRO DATUM.

Elevation.	Diameter of material.								Residue.
	Dust to 0.2 millimeter.			0.2 to 0.5 millimeter.			0.5 to 1 millimeter.		
	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Character of material.	
Down to—									
30.2	97.1	(*)	Silt and sand	0.2	(*)	Wood and sand	0.1	Wood	Wood.
29.7	99.1	(*)	do	.4	(*)	Sand and wood	.1	Coal and wood	Coal and wood.
27.8	98.4	(*)	do	.6	(*)	Wood, coal, and sand	.6	Coal, wood, and alluvium	Wood, coal, and alluvium.
26.5	98.5	(*)	do	1.4	(*)	Coal, gray and mica sand	.1	Coal and grit†	Coal.
25.2	93	2.56	Sand	6.6	(*)	Sand	.1	do	Do.
25.7	95.2		Silt and sand	3.7	(*)	Alluvium and sand	.1	Wood and grit	Coal and wood.
24.1	93.5	2.51	do	5.7	2.47	do	.1	Coal, wood, and grit	Do.
22.0	88.8	2.56	Sand	11	2.45	Wood and sand	.1	Wood and alluvium	Wood.
20.8	67.8	2.63	do	31.7	2.59	Sand (clean)	.1	Coal and grit	
19.9	93.1	2.43	Sand and silt	6.4	2.48	Sand and alluvium	.1	Coal and alluvium	Wood and coal.
19.0	93.7	2.56	Sand	6	2.44	Sand	.1	do	Coal.

BORING AT STATION 21; ELEVATION, 30.43 METERS, CAIRO DATUM.

Down to—									
28.8	65.5	1.87	Yellowish clay	27.5	2.12	Brown clay	0.3	Burnt wood and clay	Burnt wood.
27.2	92.4	2.45	Clay	6.9	2.41	Clay and sand	.1	Wood and clay	Wood and coal.
25.6	93.6	2.55	Clay and sand	5.6	2.55	do	.1	Coal and clay	
25.1	95.3	2.40	Sand	4.4	2.22	Sand and coal	.1	Coal	Coal.
23.4	84.8	2.34	Clay and sand	14.7	2.08	Clay and sand	.1	Coal and grit	Do.
23.1	54.7	2.27	Orange sand	43.2	2.69	Orange sand	1.7	Orange sand	Do.
21.9	10.6	2.57	Sand	80.2	2.69	Rough round sand	2.7	Rough round sand	Gravel.
21.0	21.4	2.42	Sand and coal	78.6	2.53	Sand and coal	.1	Coal and grit	
20.4	48.0	2.54	Sand	49.3	2.57	do	.2	Sand and coal	
18.0	67	2.46	Sand and clay	31.7	2.57	Sand and clay	.2	Clay and grit	
18.0	39.1	2.49	Sand	61	2.63	Sand and coal	.1	Sand and coal	

* Samples lost.

† Grit from stones, mica, and slag.

TABLE 5.—*Summary of borings, improvement of the mouth of Yazoo River, Mississippi*—Continued.

BORING AT STATION 27; ELEVATION, 30.78 METERS, CAIRO DATUM.

Elevation.	Diameter of material.								Residue.
	Dust to 0.2 millimeter.			0.2 to 0.5 millimeter.			0.5 to 1 millimeter.		
	Per cent.	Specific gravity.	Character of material.	Per cent.	Specific gravity.	Character of material.	Per cent.	Character of material.	
Down to—									
28.9	76.5	2.03	Light-brown clay	22.4	2.16	Brown-black clay	0.4	Clay and wood	Wood and coal.
27.5	80.3	2.48	do	17.8	2.35	Brown-black sandy clay	.5	Clay	Clay.
26.5	62.1	2.14	do	36.2	2.21	Gray clay	.7	Clay *	Do.
25.1	83.7	2.32	do	14.9	2.20	Gray-brown clay	.1	Clay and wood	
24.7	84.8	2.43	Light-brown sand and clay	14.9	2.38	Yellow-brown sand and clay	.2	Clay, coal, and sand	
24.0	80	2.46	Light-brown sand	18.4	2.46	Yellow-brown sand †	.5	Sand and clay	Coal and clay.
21.3	15	2.46	Yellow-brown sand	82	2.63	Yellow sand (clean)	2.4	Sand (clean) ‡	Sand and gravel.
19.2	21.7	2.34	Sand and clay	69.6	2.60	Gray-black sand	8	Dark coarse sand §	Gravel.
18.0	13.9	2.37	Very dark sand	79	2.65	Yellow-black sand	6.2	Yellow-black sand	Do.

BORING AT STATION 37; ELEVATION, 29.34 METERS, CAIRO DATUM.

Down to—									
21.3	59.1	2.07	Brown alluvium	38.7	2.12	Blue-brown alluvium	1.7	Alluvium and trash	Trash.
19.0	49.5	2.09	do	44.5	2.07	Gray-brown alluvium	4.9	Alluvium	Alluvium.
18.0	56.4	2.07	Gray-brown alluvium	41.9	2.05	Blue-brown alluvium	1.4	Blue alluvium	Do.

All material of this boring is known as "blue buckshot."

BORING AT STATION 41; ELEVATION, 33.62 METERS, CAIRO DATUM.

Down to—									
30.7	72.1	2.14	Light brown clay	22.6	2.16	Dark-brown clay	0.3	Alluvium	Wood and alluvium.
							1.3	Alluvium and coal	Coal.
28.4	77.9	2.31	do	20.7	2.16	do	.4	do	Do.
26.1	83.8	2.23	Light-brown sandy clay	15.9	2.13	Yellow-brown clay	.2	do	Do.

							1.4	....do	Do.

BORING AT STATION 44; ELEVATION, 34.10 METERS, CAIRO DATUM.

Down to—									
29.0	77.7	2.24	Light-brown clay	21.2	2.16	Brown-black clay	0.1	Sand and clay	
23.9	75.1	2.30	....do	23.4	2.15	....do	.9	Coal and alluvium	Coal and grit.
21.7	89.2	2.34	....do	10.1	2.22	....do. ¶	.5	....do	Do.
19.5	94.2	2.53	Yellow-gray sand	5.5	2.51	Yellow-gray sand	.1	....do	Do.

BORING AT STATION 46; ELEVATION, 34.23 METERS, CAIRO DATUM.

Down to—									
30.0	82.6	2.34	Light-brown sandy clay	15.3	2.21	Dull-brown clay	0.9	Alluvium	Petrified wood.
28.9	61.8	2.08	Dull-brown clay	36	2.12	Gray-black clay	1	....do	
22.7	66.3	2.18	Gray-brown clay	33	2.09	....do	.1	Sand and alluvium **	
18.4	66	2.24	Dull-brown sandy clay	33.3	2.34	Gray-brown sand and clay	.1	....do	

* Very tenacious, small per cent of sand.
† Small per cent of clay.
‡ Specific gravity, 2.61.
§ Specific gravity, 2.57.
‖ Small per cent of coal.
¶ Small per cent of sand.
** Traces of sand.

BORING AT STATION 14; ELEVATION, 31.43 METERS, CAIRO DATUM.

Top 0.6 meter of material was yellowish sandy clay deposit. The remainder was fine gray sand, except 0.2 meter of reddish brown clay deposit at 21.3 meters elevation. Boring down to 18.4 meters elevation.

BORING AT STATION 17; ELEVATION, 29.62 METERS, CAIRO DATUM.

Down to 25.5 meters elevation, vegetable mold to fine gray sand; thence to 23.4 meters elevation, gray sand, and down to 16.7 meters elevation, fine gray sand (quick).

BORING AT STATION 18; ELEVATION, 31.18 METERS, CAIRO DATUM.

Down to 27.7 meters elevation, stiff blue-yellow clay; down to 26.1 meters elevation, yellowish sand; down to 23.3 meters elevation, gray sand mixed with clay; down to 21.7 meters elevation, fine gray sand; down to 20.5 meters, gray sand and clay, and gray sandy deposit to 17.8 meters elevation.

BORING AT STATION 24; ELEVATION, 30.28 METERS, CAIRO DATUM.

Down to 27.7 meters elevation, blue clay, some very stiff; down to 27.5 meters elevation, brown clay; down to 23.1 meters elevation, gray and yellowish sand, some very coarse, and small per cent of clay; down to 21.7 meters elevation, coarse yellow sand; and down to 18 meters elevation, gray sand.

V 11.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

Tchula Lake or River is the name given to the east and narrowe branch of the Yazoo River, where it divides in passing Honey Islan It is wholly within Holmes County, Miss., and is about 60 miles lon Honey Island is about 100 miles above the mouth of Yazoo River, an fertile plantations join each other along its banks, their annual produc being estimated at about 20,000 bales of cotton. When the water i high enough to enable the Yazoo and Tallahatchee steamboats to cros the bars they make trips through the lake.

In accordance with requirements of river and harbor act of Marc 3, 1879, an examination of the lake was made that year with a view t its improvement, and the principal obstructions to navigation wer found to be snags and logs in the lower part, and leaning timber an shore snags along both banks, from the head to the foot of the islan The project contemplated removing these obstructions to permit ligh draft boats to enter the lake earlier in the season, and the estimate cost was $10,000 if done in one low-water season. (Report Chief Engineers, 1880, pp. 1350, 1351.) The work is of such nature that it mu be gone over to remove obstructions that are added from time to tim

The appropriations have been as follows:

By act of—	
March 3, 1881	$3,0
August 2, 1882	2,5
July 5, 1884	1,5
August 5, 1886	2,0
August 11, 1888	3,0
September 19, 1890	3,0
July 13, 1892	3,0
Total	18,0

Operations have been carried on by hired labor. Work commenc at the head of the lake July 16, 1881, and was carried down to the fo suspended September 8, 1881, and consisted of cutting and girdlin leaning timber and removing the worst snags. It was resumed at t mouth September 1, 1882, and carried up to the head of the lake, a suspended the middle of November, 1882. Nothing was done the f lowing season, as no funds were available, but December 22, 1884, wo was resumed at the head of the lake and carried down to the foot, a suspended February 11, 1885. The next work was done by the U. snag boat *Meigs*, which was employed December 19–25, 1886, and Ap 11–30, 1887, in removing the heavier obstructions and clearing a go navigable channel 90 feet wide for a distance of 44 miles. Februa 1–19, 1889, the *Meigs* was employed again, and worked from the foot the head of the lake and back, removing the heavier obstructions, aft which operations were suspended until the water should fall sufficiently f a chopping party to commence clearing the banks; but as a favorab opportunity for advantageous expenditure of the small balance avail ble was not presented during the following season, nothing was do until December 10, 1890, when the *Meigs* was used for the succeedin ten days in removing snags, tree slides, etc., from the channel. Augu 18, 1891, a chopping party commenced work at the head of the lak and continued down stream to Dunbarton, about 15 miles above th mouth, where it was suspended December 16, 1891, the available fund being exhausted. Operations during this period consisted of clearin the brush, which had grown so rapidly and to such extent that in man

places the channel did not exceed 50 feet in width, cutting shore snags and logs, felling and girdling leaning timber on both banks, and removing snags from the channel. No work was done during the fiscal year ending June 30, 1893.

This work gave greater ease and safety to the passage of boats, but the period of navigation was not prolonged; in fact, it was reported that the bars at head of the lake and below Marcella were enlarging gradually, so as to require a little higher stage of water each year to enable boats to pass through the lake.

No work was done during the fiscal year ending June 30, 1894; but it is intended to apply the available balance, as soon as the water reaches a low stage, to the removal of snags and logs in the channel, cutting leaning trees and brush along the banks, and building inexpensive brush wing dams at the bars with the material cut. Operations should extend from foot to head of the lake, as new obstructions are added every year.

With the balance available and the amount which probably will be appropriated by the pending river and harbor act, it is believed that the work needed can be done so thoroughly as not to require further attention for some years.

Money statement.

July 1, 1893, balance unexpended	$2,946.18
July 1, 1894, outstanding liabilities	9.00
July 1, 1894, balance available	2,937.18

COMMERCIAL STATISTICS.

The lake was reported navigable from January 1 to April 15 during the fiscal year.

List of stern-wheel steamboats that navigated Tchula Lake in the fiscal year 1894.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Passengers.
					Light.	Loaded.		
		Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*		
Blanks Cornwall	232.4	140	29	4.6	2 3	5 2	19	191
Des Arc	40.88	95	18	3	1 4	3 0	2	1
Birdie Bailey	109.7	111	22	3.5	1 10	4 0	10	40
Ferd R	45.5	93	16	3	1 6	2 6	.....	.....

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	1,300	1,102	1,350	1,500
Cotton seed	2,650	1,805	2,505	2,100
Live stock	37	26	24	27
Lumber	3,530	1,270	1,460	1,230
Staves	710	.....	.....	3,615
Provisions	1,300	815	1,055	500
Grain	1,120	310	1,110	600
Miscellaneous	1,110	750	1,360	700
Total	11,757	6,078	8,864	10,272
Estimated value	$684,000	$243,000	$537,000	$492,000

The Yazoo branch of the Illinois Central Railroad from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the lake, and also has a tap line from Tchula to the main line at Durant, and has diverted a large amount of the business formerly done by steamboats.

V 12.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of Tallahatchee River are in Tippah County, in nor ern Mississippi, whence it flows in a general southwesterly directi through the counties of Union, Lafayette, and Panola, joins Coldwa River in Quitman, and then, as the main stream, flows in a southe direction through Tallahatchee and Leflore counties, and unites wi the Yallabusha in forming Yazoo River.

Under river and harbor act of June 18, 1878, an examination w made that year, and the project based thereon contemplated impro ment of low-water navigation of the river from its junction with t Coldwater to the mouth, a distance of about 100 miles, by removal snags, sunken logs, and leaning timber, and the wreck of the steam *Star of the West*, 8 miles above the mouth. The estimated cost of t work was $40,000, if completed in two consecutive low-water season (Report Chief of Engineers, 1879, pp. 982–986.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$6,000	August 11, 1888	$5,0
June 14, 1880	9,000	September 19, 1890	5,0
March 3, 1881	3,000	July 13, 1892	5,0
August 2, 1882	3,000		
July 5, 1884	3,000	Total	42,5
August 5, 1886	3,500		

By the terms of the acts, $5,000 of the appropriation of 1880, $2,0 of the appropriation of 1881, and all of the appropriation of 1882 we required to be expended above the mouth of Coldwater to Batesvill in the part known as the Little Tallahatchee, which was not include in the original project or estimate of cost.

The improvement was commenced at the mouth September 18, 187 by the U. S. snag boat *Florence*, carried upstream to within 20 miles Sharkey Landing, and suspended November 20, 1879. Operatio during this period consisted of the removal of leaning timber, whic obstructed navigation at all stages. Work with the *Florence* w resumed the latter part of August, 1880, at Pecan Point, continue down to the mouth, and suspended October 18, 1880. For the stretc of river above mouth of Coldwater to Batesville a flatboat was bui and fitted up with necessary machinery, and work commenced ear in October, 1880, at the mouth of Coldwater, continued upstream Batesville, and was suspended at the close of January, 1881. Oper tions consisted of removing snags, logs, leaning timber, rafts, a drift piles. This work was resumed at Batesville June 4, 1881, a between that date and August 9, 1881, was carried down to mouth Coldwater. During this period the river was very low, and in plac blocked with drift, through which a channel was cut wide enough f boats to pass at a good stage of water. From the mouth of Coldwat the boat dropped downstream, removing the principal obstructions, far as practicable with the limited amount available, on the way, a thoroughly clearing a bad stretch of river near Pecan Point, complain of by steamboat men, after which work was suspended about the mi dle of September, 1881. Under the act of 1882 work was resumed Batesville September 15, carried down to within 6 miles of the mou of Coldwater, and suspended November 30, 1882. Owing to lack funds nothing was done the following season, but from November 1 December 6, 1884, the U. S. snag boat *Meigs* was employed in thorough

clearing the obstructions in the lower part of the river for a distance of about 25 miles above the mouth. Work with the *Meigs* was resumed under the next appropriation, December 1, 1886, but December 27 the boat was withdrawn on account of high water until May 11, 1887, after which work was continued until June 10, 1887, and carried from the mouth to Sharkey Landing before the funds were exhausted. No work was done the following year, no funds being available; but May 18–31 and June 13–17, 1889, the *Meigs* again worked over the lower river as high as Williams' wood yard, 18 miles below Sharkey, suspending operations the latter date of account of high water. November 8 to December 24, 1889, the *Meigs* was employed between the mouth and Cassity Bayou, one-half mile below Sharkey. Under the act of 1890, the *Meigs* entered this river November 1, 1890, and worked rapidly up to Sharkey Landing, as it was desired to carry operations to the mouth of Coldwater before the water should fall. The boat reached a point 6 miles above Sharkey November 7, but found the water too low to go farther and turned back, and was employed on the 40 miles below Sharkey until November 17. On the latter date a slight rise set in, and the work was carried up to Mead Landing, at the mouth of Tillatoba River, about 25 miles above Sharkey, until November 25, 1890. During the remainder of November the boat worked in the lower part of the river. Nothing further was done until June 15, 1891, when the *Meigs*, which had been working in the Yazoo, entered this stream and worked for six days, removing tree slides, etc. During the month of October, 1891, the snag boat *Meigs* was employed in the lower 50 miles of the river until the funds available were exhausted. Under the act of 1892 the *Meigs* worked over the river below Sharkey, and thence upstream to the mouth of Coldwater, having been employed September 5–30, 1892, and April 6–26, 1893.

The work from 1879 to the end of the fiscal year 1893 resulted in great benefit to navigation of the river below Sharkey Landing, enabling steamboats to run to the latter place the year round, while before the improvement commenced there was navigation for only about six months of the year. While the project contemplated work from the mouth up to the junction of the Coldwater and Little Tallahatchee, little was done above Sharkey Landing, for the reason that the available funds were not sufficient to extend operations farther, and because the steamboat interest reported that boats would not go above that landing except to make occasional trips into Coldwater River at high stages when navigation was as good and about as safe as in the lower part of the stream. In 1890, however, the steamboat men requested that operations be extended above Sharkey to the forks.

The work in Little Tallahatchee River above mouth of Coldwater to Batesville resulted in no benefit to navigation or commerce, as there has been little or no trade in that part of the stream since the war.

During the fiscal year ending June 30, 1894, little work could be done with the small balance available, operations having been as follows:

The U. S. snag boat *Meigs*, P. R. Starr, master, entered the Tallahatchee September 14, 1893, and was employed in removing obstructions to navigation of that river until September 26, when it returned to the Yazoo. Operations extended from the mouth up to Cassity Bayou, one-half mile below Sharkey Landing, and consisted chiefly of the removal of tree slides, of which there was a large number, and so extensive at places that there was not room for the snag boat to pass. At the sawmill below Glendora the channel was obstructed by rafts of

saw logs, fifteen to twenty of which had to be shifted to enable the *Meigs* to proceed upstream. Owing to insecure fastenings many heavy logs had loosened from the rafts and sunk below the mill, and all in the channel were removed. At Minter City 6 large snags and 2 sunken cribs of timber (containing 21 logs), which had lodged on the wreck of the steamer *Lake City* (sunk August, 1892), were removed. The wreck, from which the machinery had been removed in April, 1893, and the hull partly broken up, was moved to the opposite side of the river and turned bottom up, close inshore, out of the way of navigation. At Albion Landing, about a mile below Cassity Bayou, an immense tree, which had slid into the river and fallen across the channel, was removed.

The following is a summary of the work done, viz:

Snags pulled	83
Stumps removed	146
Shore snags cut	176
Logs removed from channel	266
Leaning trees cut	580
Trees girdled	2,566
Square yards willows and brush cut	150

Wreck removed, viz: Steamer *Lake City* at Minter City.

This work put the river in good navigable condition for the time, but should be repeated as soon as possible to remove obstructions, which are added continually, and the stretch above Sharkey to the mouth of Coldwater should be worked over thoroughly.

There can be no doubt that the work done has been of great benefit to navigation from the mouth to Sharkey Landing, but with the small amounts appropriated nothing could be attempted beyond the removal of the worst obstructions. In 1879 it was estimated that the obstructions below the mouth of Coldwater could be removed in two consecutive seasons of low water at a cost of $40,000. The appropriations during a period of fifteen years aggregate $42,500, of which the law required $10,000 to be expended on a part of the river not included in the project. New obstructions are added every year by sliding and caving banks, and the shifting and scouring of the channel exposes others on the bottom or lodges them upon the bars. A snag boat should be used each year to remove obstructions in the channel, but the appropriation should be large enough to permit the systematic clearing of the banks, and the sum of $10,000 can be expended to advantage in this way in one season of low water and result in permanent benefit to navigation.

Money statement.

July 1, 1893, balance unexpended	$947.44
June 30, 1894, amount expended during fiscal year	937.89
July 1, 1894, balance unexpended	9.55
July 1, 1894, outstanding liabilities	6.50
July 1, 1894, balance available	3.05
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

COMMERCIAL STATISTICS.

This river was navigable to Sharkey Landing the whole year, and during high stages to Coldwater River.

List of stern-wheel steamboats that navigated Tallahatchee River in fiscal year 1894.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Blanks Cornwell	232.40	140	29	4.6	2 3	5 2	Yazoo River and Sharkey	24	210
John F. Allen	133.90	130.2	24	4.2	1 8	4 0	....do	64	180
Des Arc	40.88	95	18	3	1 4	3 0	....do	10	1
John M. Abbott	97.78	92	20	3.6	.....	.....	Not reported	....	....
H. M. Townsend	89.70	116.7	18	3.1	.....	.....	New Orleans and Coldwater River.	1	....
Ferd R	45.50	93	16	3	1 6	2 6	Yazoo City and Coldwater River.	4	....
Uncle Billie	79.81	88	17.7	3.9	1 4	3 0	Towing between Greenwood and Tallahatchee and Coldwater rivers.	....	....

Summary of commerce reported.

Articles.	1893-'94.	1892-'93.	1891-'92.	1890-'91.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	4,338	3,141	5,588	4,000
Cotton seed	7,300	4,400	8,257	6,000
Hides and skins	3	3	53	5
Live stock	30	30	31	32
Lumber	1,400	1,300	1,188	1,424
Staves	14,346	3,447	3,204	9,245
Provisions	4,700	3,450	5,571	4,200
Grain	6,100	1,800	5,725	4,800
Saw logs	49,500	26,700	24,473	19,000
Miscellaneous	5,100	4,100	6,329	5,000
Total	92,817	48,371	60,419	53,706
Estimated value	$2,372,000	$908,000	$2,428,000	$2,115,000

The Yazoo and Mississippi Valley Railroad has a branch line from Clarksdale, Miss., to Minter City, on the Tallahatchee, which will be extended to connect with the Georgia Pacific near Greenwood; and the Georgia Pacific and Illinois Central railroads at Greenwood are competitors for the trade of the Tallahatchee River.

V 13.

IMPROVEMENT OF STEELE AND WASHINGTON BAYOUS, MISSISSIPPI.

Steele Bayou has its source in Swan Lake, in Washington County, Miss., flows in a general southerly direction, forming the outlet of Lake Washington, with which it is connected by Washington Bayou, a stream about 7 miles in length, and enters Yazoo River about 12 miles above its mouth. Its course is parallel to the Mississippi and its length about 85 miles; the fall is slight and the stream is not navigable except when the Mississippi is high enough to fill the lower portion with backwater.

An examination of Steele Bayou from its mouth to Swan Lake was made under river and harbor act of August 2, 1882, and in January,

1883, the officer in charge reported adversely to the improvement. (Report Chief of Engineers, 1884, pp. 1360–1362.)

The following appropriations have been made, viz:

By act of—	
July 5, 1884	$2,500
August 5, 1886	2,500
August 11, 1888	2,500
September 19, 1890	2,500
July 13, 1892	2,500
Total	12,500

The act of 1884 provided for improving Steele Bayou alone; Washington Bayou has been included in subsequent appropriations. The project contemplates removing snags, stumps, drift, and leaning timber to improve high-water navigation.

Work with a chopping party was commenced at the foot of Swan Lake November 1, 1884, was carried down to the mouth of the bayou and suspended February 11, 1885, and consisted of the removal of the principal obstructions only. It was resumed November 1, 1886, at the head of Washington Bayou, continued down Steele Bayou about 40 miles, and suspended early in January, 1887, by high water. Nothing was done the following season, as the unexpended balance was not sufficient to resume work. February 11, 1889, a steamboat was hired and employed for sixteen days in removing obstructions below the mouth of Washington Bayou down to within 8 miles of the mouth, and was then withdrawn on account of high water. July 12–17, 1889, a light-draft steamboat was employed to remove obstructions from Bon Eagle Plantation down to the mouth, about 22 miles. Under the act of 1890, the U. S. snag boat *Florence* was sent into Steele Bayou February 8, 1891, and worked until the end of that month, when it was withdrawn on account of high water. Operations extended from the mouth up to the foot of Poindexter Island, about 50 miles. From December 21, 1891, to February 12, 1892, a chopping party carried work from the mouth upstream about 22 miles before the available balance was exhausted.

From 1884 to the end of the fiscal year 1893 Steele Bayou was worked over twice from Swan Lake to the mouth, and the obstructions in Washington Bayou were removed in 1886, resulting in greater ease and safety to steamboat navigation at high stages, but operations were by no means thorough, on account of the small appropriations.

No work was done during the fiscal year ending June 30, 1894. As soon as practicable, the work of removing obstructions to high-water navigation will be resumed, and will continue until the funds available are expended.

The following extract from my report of 1893 remains applicable to this work:

> The region bordering the upper part of Steele Bayou and Washington and Sw[illegible] lakes furnishes the principal products. The lower part of the bayou is subject t[illegible] overflow from backwater, and not much land in the vicinity is cultivated. T[illegible] west side of Lake Washington is near the Mississippi, and a loop line of the Yaz[illegible] and Mississippi Valley Railroad, from Coahoma to Rolling Fork, passes between Sw[illegible] Lake and Lake Washington, and diverts the main traffic from the bayou before n[illegible] igation opens.
>
> Steamboat navigation in Steele Bayou was not commenced until 1879, and sin[illegible] the construction of the railroad in 1884 it has decreased steadily, until for seve[illegible] years past the trade has amounted to little or nothing. In view of the limited co[illegible] merce to be benefited and the cost of maintaining the work by the removal of n[illegible] obstructions added from time to time, it is not believed that any further amou[illegible] can be expended profitably for the improvement of this stream, and estimates [illegible] pose are omitted.

Money statement.

y 1, 1893, balance unexpended	$2,443.57
ne 30, 1894, amount expended during fiscal year	.31
ly 1, 1894, balance available	2,443.26

COMMERCIAL STATISTICS.

Steele Bayou is considered navigable only when there is a stage of 33 feet or above at Vicksburg. During the fiscal year the river was at or above that stage July 1–9, 1893, February 16 to March 11, and March 13 to May 5, 1894.

There was no steamboat in Steele Bayou during the year.

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton			9	1	8
Cotton seed		70	190	50	346
Saw logs	1,500	600	1,335	150	
Miscellaneous			50	125	
Total down freight	1,500	670	1,584	326	354
Return freight			100	300	350
Total	1,500	670	1,684	626	704
Estimated value	$6,500	$4,000	$10,000	$16,000	$50,000

V 14.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

Big Sunflower has its source in Mud Lake, Coahoma County, Miss., 2½ miles from Friar Point, on the Mississippi, flows in a general southerly direction, and enters Yazoo River about 45 miles above its mouth. During extreme high water it is navigable to Clarksdale, about 280 miles above the mouth; but Faisonia, about 144 miles above the mouth, ordinarily is considered the head of navigation.

Under river and harbor act of June 18, 1878, an examination of this river was made, and the project based thereon contemplated the removal of snags, sunken logs, and leaning timber obstructing navigation, and building wing dams to scour a channel from 3 feet to 40 inches deep through Oliphant Bar and Muscle Shoals, at an estimated cost of $66,000. Oliphant Bar begins at the mouth of the river and extends upstream 15 miles; Muscle Shoals begin about 38 miles above the mouth and extend upstream about 5 miles. (Report Chief of Engineers, 1879, pp. 982–984.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$20,000	August 11, 1888	$5,000
June 14, 1880	8,000	September 19, 1890	5,000
March 3, 1881	4,000	July 13, 1892	5,000
August 2, 1882	5,000		
July 5, 1884	5,000	Total	62,000
August 5, 1886	5,000		

The improvement commenced in the fall of 1879. A light-draft steamboat was chartered September 11 and employed until November 27, 1879, in removing snags, logs, etc.; building 10 wing dams at Oliphant Bar, which increased the depth of water to 3 feet where there had been

but 18 inches, and 3 wing dams at Muscle Shoals. These dams were inexpensive structures of light piles and brush, but answered the purpose for which intended. Work was resumed June 19, 1880, with a light-draft steamboat hired for the purpose, and continued until December 4, 1880, when it was suspended by high water. During this period operations were carried from the mouth up to Faisonia, and consisted of removing snags and logs from the channel, leaning timber along the banks, and building wing dams at Callao and Vick Landing, which increased the depth of channel from 18 inches to 3½ feet. The next season a chopping party commenced the removal of leaning timber and snags at Clarksdale, June 10, 1881. This work was carried downstream until June 24, when the party was moved down to Faisonia, where operations ceased in 1880. From June 29 to September 15, 1881, work was carried from Faisonia upstream to Dougherty Ferry, after which the force was transferred to the lower river and employed in removing obstructions, repairing the dams at Callao and Vick Landing, and building new dams at Shell Ridge, until work was suspended by high water October 27, 1881. In 1882 a chopping party commenced work August 26 and continued until the latter part of January, 1883, from Standing Stump upstream to Clarksdale, including all the upper river that had not been worked over previously. Nothing was done the following season, as no appropriation was made. Under the act of 1884 a light draft steamboat was chartered October 12 and employed in the lower river until December 21, 1884, removing snags, logs, etc., and building and repairing wing dams where needed. This work was supplemented by operations of the U. S. snag boat *Meigs*, January 1–18, 1885. From June 14 until August 26, 1887, operations were continued below Faisonia by means of a light-draft steamer hired for the purpose, and a force of 25 to 30 men, removing obstructions from the channel and building wing dams where needed at the shoals. June 7 to July 7 and September 1 to 9, 1889, a steamboat was employed in going over the work below Faisonia, removing obstructions and building and repairing dams. January 10 to February 13, 1891, the U. S. snag boat *Meigs* was employed in the river below Faisonia, but was withdrawn the latter date on account of high water. In addition to the removal of obstructions, brush dams were built by the *Meigs* at head of Muscle Shoals and at Hollywood Bar. The water remained too high to resume work until the latter part of May, but June 1, 1891, the snag boat *Florence* was sent into the river and worked until the end of the month removing obstructions between the mouth and a point 18 miles above Faisonia. August 18–31, 1891, the small balance available was expended by the snag boat *Florence* in removing obstructions between the mouth and Faisonia. January 31 to March 25, 1893, the U. S. snag boat *Meigs* worked over the river between the mouth and Faisonia and removed a large number of obstructions.

From the foregoing résumé it will be seen that the work from 1879 to the close of the fiscal year 1893 extended over the navigable part of the river, from Clarksdale to its mouth, though little has been done above Faisonia since 1882, as it would have resulted in no benefit to commerce or navigation to improve the upper river and permit the lower to remain obstructed, the appropriations made having been too small for work over the whole. It has been the endeavor to obtain the best results within the means provided by keeping the lower river open the year round, with a view to extending navigation upstream to Lehrton or higher as the work progresses. Before the improvement commenced the river was navigable for light boats about six months of the year; now it is navigable the year round, but difficult and danger-

ous at low stages on account of shoals, snags, and sunken logs. Larger boats are used and make the trips in little more than half the time required formerly, and freight rates are reported to be 50 per cent less. The lands along the river have been cleared and settled rapidly of late years, which is attributed partly to the improved navigation.

No work was done during the fiscal year ending June 30, 1894, as the balance available was too small to permit it.

The following extract from my report of 1891 remains applicable to this work:

It is recommended that future appropriations shall not restrict expenditures to designated stretches of river in order that the funds may be applied where the work is needed most and where it will yield the greatest benefit to navigation.

The estimate of $66,000, made in 1879, for the improvement of this river (p. 984, Report Chief of Engineers, 1879) did not contemplate doing the work at irregular intervals extending over a period of fifteen years, as it will with the usual appropriations, but was made with a view to finishing it in not more than three or four consecutive seasons. As new obstructions are added from time to time, it is impossible to make any definite estimate, but if an appropriation of not less than $20,000 is made it can be spent to advantage and with economy in one or two low-water seasons and result in greater benefit to navigation and work of a more lasting character than a larger sum by small allotments every other year.

Money statement.

July 1, 1893, balance unexpended	$697.09
June 30, 1894, amount expended during fiscal year	40.72
July 1, 1894, balance unexpended	656.37
July 1, 1894, outstanding liabilities	13.33
July 1, 1894, balance available	643.04
Amount that can be profitably expended in fiscal year ending June 30, 1896	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The river was navigable to Woodburn, 80 miles above the mouth, the entire year, and to Faisonia, 144 miles above the mouth, from October 18, 1893, to May 20, 1894.

List of steamboats that navigated Big Sunflower River in fiscal year 1894.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
John F. Allen	Stern-wheel.	133.90	130.2	24	4.2	1 8	4 0	Vicksburg and Faisonia	15	90
Des Arc	...do..	40.88	95	18	3	1 4	3 0	Vicksburg, Woodburn, and Lehrton.	15	111
Birdie Bailey	...do..	109.74	111	22	3.5	1 10	4 0	Yazoo City and Campbellsville.	30	200
L. H. Sargent	...do..	85.46	116.2	22.4	4.3	1 10	3 0	Vicksburg and Lehrton.	6	....
								Vicksburg and Campbellsville.	6	....
Thos. A. Hendricks (towboat.)	...do..	81.86	108	22.5	4.2	.....	.....	Not reported	....	....
Ferd. R.	...do..	45.50	93	16	3	1 6	2 6	Yazoo City and Campbellsville.	10	....
Crown Point	...do..	159.14	123	25	4.2	2 2	4 4	Vicksburg and Campbellsville.	1	....
Hibernia	...do..	157.06	135	25	4	2 0	5 0	....do	21	110
Joe Seay (with barges).	Tug..	27.74	75	16	6	7 0	8 0	Vicksburg and Dawson Bayou.	2	....

Summary of commerce reported.

Articles.	1893–'94.	1892–'93.	1891–'92.	1890–'91.	1889–'90.	1888–'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	2,400	2,699	4,118	2,375	2,594	4,000
Cotton seed	5,700	5,250	5,450	3,500	3,975	6,000
Hides	12	19	12	.....	.....	1
Live stock	38	250	205	70	150	150
Saw logs	5,650	19,000	21,835	15,400	4,000	.....
Lumber	780	1,130	906	920	869	.....
Staves	9,405	9,840	4,430	3,219	5,250	490
Miscellaneous	2,050	1,088	2,549	2,027	.....	3,880
Total down freight	26,035	39,276	39,565	27,511	16,838	14,521
Return freight	4,285	4,023	7,489	4,473	5,322	9,680
Total	30,320	43,299	47,054	31,984	22,160	24,201
Estimated value	$988,000	$893,000	$1,354,000	$945,000	$1,240,000	$1,858,000

The Yazoo and Mississippi Valley Railroad crosses the river at Clarksdale and thence runs south parallel to the stream at distances varying from 5 to 20 miles. The Georgia Pacific division of the Richmond and Danville Railroad crosses the river at Baird with a line running from Arkansas City, on the Mississippi River, to Atlanta, Ga.

V 15.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

Big Hatchee River has its source in northern Mississippi, flows in a northwesterly and then westerly direction through the most productive region of west Tennessee, and enters Mississippi River 50 miles above Memphis. Navigation of this stream was commenced as early as 1827. In 1841 and 1842 the State of Tennessee appropriated $100,000 for improvement of rivers in the western part of the State, one-third of which was expended on Big Hatchee, after which considerable commerce developed, six or seven steamboats having been employed during the cotton season, and it is stated that there was navigation for light-draft boats the year round. In 1866 the legislature of Tennessee declared the stream unnavigable and authorized the construction of fixed railway bridges across it, in consequence of which navigation was suspended until 1879, when the act was repealed and the railroad companies changed their bridges to conform to the law.

Under section 2 of river and harbor act of August 14, 1876, which provided for "examination and survey of such rivers and harbors as, in the judgment of the Secretary of War, will subserve the general interests of commerce," an examination of this river was ordered; but, in view of the State law declaring the river unnavigable, it was deferred until after repeal of the act in 1879. The project, based upon this examination, contemplated the removal of snags, logs, leaning timber, etc., to render the stream navigable for light-draft boats throughout the year, from Bolivar, Tenn., to the mouth, a distance estimated to be about 240 miles. The plan contemplated completing work in three consecutive seasons of low water, at a cost of $30,000. (Report Chief of Engineers, 1880, pp. 1330–1332.)

The appropriations are as follows:

By act of—		By act of—	
June 14, 1880	$10,000	August 11, 1888	$5,000
March 3, 1881	3,500	September 19, 1890	5,000
August 2, 1882	3,000	July 13, 1892	3,500
July 5, 1884	2,500		
August 5, 1886	3,000	Total	35,500

Operations from the commencement of the improvement by the United States to the close of the fiscal year 1893 were as follows:

A chopping party commenced work at Bolivar August 13, 1880, and continued downstream to the mouth of the river, which was reached December 10, 1880. This work consisted chiefly of clearing the leaning timber, but snags and logs were removed from the channel wherever practicable with the means at hand. In 1881 a chopping party resumed work at Bolivar June 22, and between that date and October 15 carried it down to the mouth, giving special attention to the removal of obstructions in the channel.

August 28 to November 4, 1882, the work was gone over again from Bolivar to Reed Landing, 27½ miles above the mouth, many new obstructions having been added during the year by caving banks, etc. Owing to lack of funds nothing further was done until December 14, 1884, when a chopping party commenced work at Piljerk Landing, 40 miles above the mouth, and continued upstream about 40 miles, thoroughly removing all obstructions to navigation until February 10, 1885, when operations were suspended by high water. Nothing was done the following low-water season, as the balance available was insufficient to resume operations. October 15, 1886, work was begun at the mouth and continued until January 15, 1887, when it was stopped by high water, having been carried up to Rialto, about 60 miles. The small balance was expended June 17–27, 1887, in working from Rialto back to the mouth, giving a fair navigable channel in that stretch of river. The next work, April 5 to June 14, 1889, was carried from Rialto upstream to the Louisville and Nashville Railroad bridge, a distance of about 60 miles, and August 19 to October 31, 1889, a hand-propelled snag boat was employed in removing obstructions from the bottom of the river below Rialto, clearing a good channel between that place and the mouth, with a depth of 2½ feet at low stages. The next work was done by the U. S. snag boat *Florence*, January 1 to March 5, 1892, between the mouth and Green Landing, about 67 miles above, and was suspended by high water.

Before the improvement commenced the river virtually was unnavigable by reason of the obstructions. In 1889 it was reported navigable for seven months; during the fiscal year 1891 it was reported navigable for nine months, and during the fiscal year 1893 it was reported navigable for eight months. Between Bolivar and its mouth the stream is crossed by four railroads, about 60 miles apart, which transport the principal products of the adjacent country, and the main effect of the work done has been to facilitate the transportation of timber and staves and prevent excessive rates of freight. The fixed bridge of the Tennessee Midland Railway, about 60 miles below Bolivar, prevents navigation by steamers above that point. If that bridge were provided with a draw, and the snags and leaning timber removed so as to permit light-draft boats to run the year round, there is a possibility that steamboat trade might revive, though not to the extent of the period before the railroads were built.

During the fiscal year ending June 30, 1894, operations were continued as follows:

Work in this stream had been delayed for some time, for the reason that none of the floating plant belonging to the district could be spared at a time when the conditions were favorable, and because a suitable vessel could not be hired for the purpose without paying a large proportion of the available funds for its use. Under authority of the Chief of Engineers a pile-driver barge belonging to the district in

charge of Captain Roessler was transferred in May, 1884, for temporary use on this work. The barge was repaired at Memphis, Tenn., fitted up for use as a quarter boat, and a hand capstan was placed on each end for pulling logs, etc., it being intended to destroy the heavier obstructions in the channel by the free use of high explosives. The repairs were completed May 14, supplies, etc., were taken aboard, and a chopping party was organized, under Overseer Watkins Decker. May 17–19 the barge was towed by the U. S. steamer *H. M. Graham* from Memphis up the Big Hatchee, 2 miles above Price Bluff, about 20 miles from the mouth. The steamer being unable to proceed farther upstream on the low stage of water, the barge was cordeled by the crew up to Rialto, the crossing of the Chesapeake, Ohio and Southwestern Railroad, where work commenced June 2, continuing upstream to the end of the year, and extended to the first short bend above Green Cut-off, a distance of 14¼ miles.

The channel was found badly obstructed by heavy trees, that had fallen into the stream from caving banks, which were difficult to remove, as generally where the banks were caving the water was from 10 to 15 feet deep. Along the banks many dangerous leaning trees, shore snags, stumps, and logs were removed.

The following is a summary of the work done, viz:

Snags removed from channel	1,979
Stumps removed	519
Shore snags removed	62
Logs cut	406
Leaning trees removed	1,007
Leaning trees topped	3
Trees girdled	662
Square yards of brush and willows cut	28,420

Overseer Decker reports the merchants and others living along the river below Rialto are considering the question of putting in a steamboat to secure a reduction of freight rates, as they claim railroad charges are excessive, and for this reason the available balance will be applied to the removal of obstructions between Rialto and the mouth, in which work the party in Forked Deer River will aid as soon as operations in that stream are suspended. This will put the lower 70 miles of river in fairly good navigable condition, and probably enable light-draft boats to run that portion the year round.

Overseer Decker reports that if the snags and logs were cleared from the channel the stream would afford navigation all the year for boats drawing 3 to 4 feet of water, but he estimates the cost of extending the work up to Hatchie Station, at the crossing of the Paducah, Tennessee and Alabama Railroad (Tennessee Midland), about 178 miles above the mouth, at $50,000, provided that amount were expended in three consecutive seasons of low water. I can find no reason for changing the recommendation made in my last report, viz:

> The small amount of commerce to be benefited is not at all commensurate to the cost of continuing this improvement or to maintaining what has been done, and for this reason it is not believed that an additional appropriation can be expended profitably, unless a greatly increased business be developed.

Money statement.

July 1, 1893, balance unexpended	$5,678.48
June 30, 1894, amount expended during fiscal year	2,423.20
July 1, 1894, balance available	3,255.28

COMMERCIAL STATISTICS.

The river was reported nagivable to Bolivar for about seven months of the fiscal ar.

List of steamboats engaged in navigating Big Hatchee River in fiscal year 1894.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
hite Oak*	Tug	31.32	69	13	0.4	5 6	8 6	Mouth and Price Bluff	1
y Patton*	Stern-wheel.	63.04	100	21.3	5.6	3 6	4 0	do	4
ncle Billy	do	79.81	88	17.7	3.9	1 8	4 0	No report	
elcome*	Tug	11.33	64.8	16.3	5.6	6 0		Mouth and 6 to 10 miles upstream.	3

* Towing out stave barges and saw logs floated down river to near mouth.

Summary of commerce reported.

Articles.	1893-'94.	1892-'93.	1891-'92.	1890-'91.
	Tons.	*Tons.*	*Tons.*	*Tons.*
otton				23
umber (saw logs)	18,920		4,450	6,010
taves and heading	4,920	5,079	500	11,600
liscellaneous				25
Total	23,840	5,079	4,950	17,658
Estimated value	$98,000	$34,500	$30,000	$184,500

The Illinois Central Railroad (Mississippi and Louisiana divisions) crosses the river at Bolivar, the head of proposed improvement. The Paducah, Tennessee and Alabama Railroad (Tennessee Midland) crosses at Hatchie Station, about 178 miles above the mouth; the Louisville and Nashville Railroad crosses at Big Hatchie Station, about 117 miles above the mouth; and the Chesapeake, Ohio and Southwestern Railroad crosses at Rialto, about 57 miles above the mouth.

V 16.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

Main Forked Deer River, 24 miles long, is formed by the junction of the North and South forks in Dyer County, west Tennessee, about 9 miles below the town of Dyersburg, flows in a southwesterly direction, enters Obion River 4 miles above its mouth, and thus finds an outlet to the Mississippi at Hale Point, 95 miles above Memphis. Originally the mouth of Forked Deer River was near Ashport, 18 miles below Hale Point, but about fifty-five years ago the State of Tennessee cut a canal to a bend of the Mississippi (now the mouth of Obion River), shortening the length of main Forked Deer River about one-half. The original outlet below the canal is closed with snags and drift, and is called "Old" and "Lost" channels. The canal is known as "Tigertail." North Fork is formed by several small creeks near Trenton, in Gibson County, flows in a westerly direction to Dyersburg, thence southwesterly. South Fork heads in McNairy and Henderson counties, and flows in a

general northwesterly direction. Appropriations aggregating $43,000 were made by the State of Tennessee for the improvement of Forked Deer River at various times within the twenty years preceding 1874, but their expenditure resulted in little or no benefit to navigation.

Under river and harbor act of March 3, 1873, an examination was made from Dyersburg, on the North Fork, to mouth of main river, the report on which recommended that in view of the cost of the work, in comparison with the small amount of commerce to be benefited, the improvement should not be undertaken by the United States. (Report Chief of Engineers, 1874, Part I, pp. 372–380.) Under act of June 14, 1880, an examination of the South Fork and reexamination of the North Fork and main river were made (Report Chief of Engineers, 1881, pp. 1489-1497), and under act of August 5, 1886, a third examination of North Fork below Dyersburg and the main river was made. (Report Chief of Engineers, 1887, pp. 1494, 1495.)

The original project contemplated the removal of snags, logs, leaning timber, etc., to give greater ease and safety to navigation of South Fork between Brownsville Landing and its junction with North Fork, a distance estimated to be about 73 miles, which was modified in 1883 so as to extend operations up to Jackson, Tenn., the head of navigation, about 74 miles above Brownsville Landing. By act of 1888 North Fork and main river were added under the general title improving Forked Deer River, and the project contemplated the same class of work in the 9 miles of North Fork below Dyersburg, and thence down the main stream to the mouth. The estimates of cost were $19,250 for South Fork, $4,500 for North Fork, and $7,000 for the main river, based on plans for completing work in one season.

The appropriations have been as follows:

By act of—	
August, 2, 1882, for South Fork	$3,000
July 5, 1884, for South Fork	2,000
August 5, 1886, for South Fork	5,000
August 11, 1888:	
For South Fork	2,500
For North Fork	4,500
For main river	2,500
September 19, 1890, for North Fork and main river	2,500
July 13, 1892, for completing improvement	3,000
Total	25,000

Operations from the beginning of the improvement by the United States to the close of the fiscal year 1893 were as follows:

Work with a chopping party commenced at the mouth of South Fork July 7, 1883, and continued until November 16, 1883. During this period the water was at a low stage, and the removal of leaning timber, logs, snags, etc., was carried upstream to Jackson. Under the act of 1884 work was resumed October 1, 1884, at Jackson and carried downstream about 54 miles to Bell Depot, and suspended December 17, 1884, the available funds being exhausted. Nothing further was done until October 27, 1886, when operations were begun at the mouth, and between that date and June 16, 1887, were carried upstream to within 4 miles of Bell Depot. No work was done the following season, no funds being available. The next and last work done in South Fork commenced early in December, 1888, near the brush dam below Bell Depot. By means of explosives a channel 100 feet wide was cleared through the dam, after which the removal of snags, logs, leaning timber, etc., was carried up to Jackson and back to the mouth, reaching

e latter point March 9, 1889. April 1–17, 1889, the balance available as expended by a small hand-propelled snag boat in removing leaning mber and heavy channel obstructions which had collected in the 8 iles above the mouth.

Work in the North Fork below Dyersburg was commenced by a hopping party October 3, 1888, at the mouth, and the principal shore ork was completed November 27, 1888. Channel work with a hand-ropelled snag boat, fitted with light shears and steam power, com-ienced December 6, 1888, and continued, when the stages of water ould permit, until May 31, 1889, resulting in a good channel with a east depth of 2½ feet at ordinary low stages. November 1–23, 1889, he work gone over and it was found that the channel had scoured onsiderably and was well defined, with caving banks at few places. Wherever there were evidences of caving the banks were cleared for ome distance back, and the snags and stumps that had been scoured oose were removed.

Work in the main river was begun with the hand-propelled snag boat November 10, 1888, but after twelve days' work was suspended by igh water, which prevented resuming operations until June 10, 1889. From that date until the end of July, 1889, with the exception of a week's suspension by a sudden rise, the snag boat and a chopping party were employed in removing the obstructions as thoroughly as practicable with the limited amount available. At extreme low water the following October a number of stumps obstructing the channel below White Oak Landing were removed. November 2 to December 30, 1891, the U. S. snag boat *Florence* worked over the main river and North Fork below Dyersburg at a low stage of water and did effective work in the way of removing obstructions from the channel.

The amounts expended to June 30, 1893, were $12,500 for South Fork and $9,500 for North Fork and the main river. With these expenditures the two forks were put in fairly good navigable condition, and the removal of obstructions from the main river enabled small boats to navigate it with greater ease and safety for a period of about eight months of the year. Navigation of South Fork is carried on by flatboats, loaded with staves and lumber, and rafts of saw logs. Before the improvement commenced about one boat in three was lost on account of the obstructions. Now they make the trip in comparative safety and at less cost. The work in North Fork below Dyersburg enabled boats to run at a stage 3 feet lower than formerly.

During the fiscal year ending June 30, 1894, operations were continued, as follows:

Work in this stream had been delayed by lack of plant. None of the boats belonging to the district could be spared at a time when conditions were favorable for effective work, and it was found impracticable to hire a suitable vessel at reasonable cost. In May, 1894, under authority of the Chief of Engineers, a pile-driver barge belonging to the district in charge of Captain Roessler was transferred for temporary use in this stream. The barge was repaired at Memphis, Tenn., fitted up for use as a quarter boat, and a hand capstan was placed on each end for pulling logs, etc., it being intended to destroy the heavier obstructions in the channel by the free use of high explosives. The repairs were completed May 14; supplies, explosives, etc., were taken aboard, and May 17–21 the barge was towed by the U. S. steamer *M. Graham* from Memphis into the North Fork about 4 miles below Dyersburg. The work was carried on under the supervision of Overseer Watkins Decker, in conjunction with the improvement of Big

Hatchee River. Operations commenced May 22 at Dyersburg, and by June 22 had been carried down to the mouth of North Fork. This branch of the river, being narrow, was cleared thoroughly, the chief obstructions having been snags and logs in the channel. Many of the latter were sunken saw logs, ranging from 2½ to 5 feet in diameter and 8 to 30 feet long. This class of obstructions was hauled out and destroyed with explosives, and the overseer in charge reported that their removal will give an increase of 2 to 3 feet of navigable depth. From the mouth of North Fork work was continued down the main stream, and June 30 had progressed to Skipper Cut-off, a distance of about 17 miles. Operations will be completed about July 10, after which the party will be transferred to Big Hatchee River, to expedite work in that stream.

The following is a summary of the work done during the year, viz:

Snags removed from channel	1,97
Stumps removed	1,42
Logs removed	2,33
Shore snags removed	1,28
Jams removed	
Side jams removed	
Trees removed from channel	
Leaning trees removed	
Trees girdled	16,87
Square yards of brush and willows cut	16

In view of the limited commerce (present and prospective) to be benefited, it is not believed that any further appropriation can be expended profitably, and no estimate is made for continuing the work.

Money statement.

July 1, 1893, balance unexpended	$3,000.00
June 30, 1894, amount expended during fiscal year	2,628.22
July 1, 1894, balance unexpended	371.78
July 1, 1894, outstanding liabilities	2.10
July 1, 1894, balance available	369.68

COMMERCIAL STATISTICS.

During the fiscal year the main river and North Fork were reported navigable for light-draft boats from the middle of December to June 28.

List of steamboats that navigated Forked Deer River in fiscal year 1894.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet*	*Ft. in.*	*Ft. in.*			
James Laughlin*	Tug	28.76	71.5	15	4.5	5 0	5 6	Obion Mills and Dyersburg.	73	350
Peoria Belle*	do	31.07	70.3	12.6	4.4	3 6	5 6	Dyersburg and Mississippi River.	85	375
Mima	Stern-wheel.	26	.....	.....	.....	1 1	2 6	do	50	.....
Mary Louisa	do	39.90	51	16	3	.....	.....	No report	.....	.....
White Oak*	Tug	.....	.....	.....	.....	.....	.....	Mississippi River and South Fork.	1	.....

* Towed three or more barges.

Summary of commerce reported.

Articles.	1893-'94.	1892-'93.	1891-'92.	1890-'91.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton			98½	6
Cotton seed			100	25
Hides and skins			2½	
Live stock			18	
Lumber (principally saw logs)	176,000	25,650	12,000	9,200
Staves	16,300	445	3,580	24,000
Miscellaneous	1,028	276	44	
Total	193,328	26,371	15,843	33,231
Estimated value	$347,000	$130,000	$108,000	$250,000

South Fork is crossed at Jackson by the Illinois Central, the Mobile and Ohio, and the Paducah, Tennessee and Alabama (Tennessee Midland) railroads, and at Bells Depot by the Louisville and Nashville Railroad; and the Chesapeake, Ohio and Southwestern Railroad crosses North Fork at Dyersburg.

V 17.

WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were designed to secure information from continuous records, with a view to protection of the alluvial lands against overflow, the improvement of navigation, and to give correct reports of the stages of water for the benefit of river men and planters. They were ordered by joint resolution of Congress approved February 21, 1871 (section 5252, Revised Statutes), viz:

SEC. 5252. The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in the vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico; and at or in the vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas, and Alexandria, on the Red River, and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriation for the improvement of rivers and harbors, but the annual cost of the observations shall not exceed the sum of five thousand dollars.

Soon after the gauges were established and observations commenced it became evident that the sum of $5,000 annually was not sufficient to cover the expenses of repairs and frequent inspections essential to accuracy, and during the years in which no appropriations were made for improvement of rivers and harbors various expedients had to be resorted to to maintain the service. In 1878 observations were stopped for want of funds, but many observers continued the records without compensation; in 1884 a deficiency appropriation was made for their continuance; in 1886 the Mississippi River Commission paid the observers and repaired and inspected the gauges on the Mississippi to prevent suspensions, and in 1887-'88 the readings were continued voluntarily by the observers. At this rate it was easily seen that the work would have to cease unless new legislation should be enacted for maintaining the gauges, and the river and harbor act of August 11, 1888, provided a permanent indefinite appropriation for the purpose, as follows:

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however*, That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The amount appropriated in the act of August 11, 1888, was—

For gauging the waters of the Lower Mississippi River and its tributaries as provided for in joint resolution of twenty-first of February, eighteen hundred and seventy-one, nine thousand six hundred dollars: *Provided*, That three thousand six hundred dollars of same is authorized to be expended in paying the expenses of gauging the said waters during the fiscal year ending June thirtieth, eighteen hundred and eighty-eight.

The same act, in the item of appropriation for continuing operations upon the reservoirs at the headwaters of the Mississippi River, provided as follows:

And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

Although the act provides an annual appropriation of not to exceed $9,600, and although that amount was allotted for the fiscal years 1889, 1890, and 1891, a ruling was made in April, 1891, that only $6,000 could be drawn from the Treasury during each fiscal year. In consequence of that ruling observations at the greater number of the gauges for the last quarter of the fiscal year 1891 were paid for from the appropriations for works benefited by maintaining the records, as the funds in hand were exhausted, $900 having been allotted for gauging at or near St. Paul.

The appropriations and allotments for this work have been as follows:

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000
June 10, 1872	5,000
March 3, 1873	5,000
June 23, 1874	5,000
March 3, 1875	5,000
Specific appropriations by river and harbor acts of—	
August 14, 1876	5,000
June 18, 1878	5,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	5,000
August 2, 1882	5,000
Deficiency act of March 12, 1884	2,100
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000
August 5, 1886	5,000
Allotted from specific appropriation by river and harbor act of August 11, 1888	8,700
Deficiency act of October 19, 1888	3,600
Allotments from permanent appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:	
1890	9,000
1891	8,700
1892	5,100
1893	5,500
1894	5,500
Total	113,200

Prior to 1892 it was held that the unexpended balance of an allotment at the close of a fiscal year could not be used in addition to the allotment for a succeeding year, but July 13, 1892, the Secretary of the Treasury decided that the allotments made under section 6 of the act of August 11, 1888, were "no limit" appropriations.

The following statement shows the disposition of the funds apportioned to this work:

Amount expended to June 30, 1894	$103,211.25
Amount of deficiency appropriation of October 19, 1888, not used	3,600.00
Balance of appropriation by act of August 11, 1888, not expended	1,566.29
Balance of allotment for fiscal year 1890, not expended	1,281.66
Portion of allotment for fiscal year 1891, withheld at U. S. Treasury under ruling that only $6,000 can be drawn each fiscal year	3,518.34
Balance unexpended July 1, 1894	22.46
Total, as above	113,200.00

The gauges ordered by the resolution of February 21, 1871, were established the latter part of that year, except that at Carrollton, La., established in January, 1872. A gauge was placed at the mouth of White River instead of at Napoleon, Ark., as the latter place was caving into the river. Two gauges were established at Louisville, Ky., one at head and one at foot of the falls, and at the request of the steamboat interest, a gauge was set up at Natchez, Miss. In August, 1873, a gauge was established at Nashville, Tenn., on Cumberland River. In February, 1890, additional gauges were established on Red River at Shreveport, La., and Garland and Fulton, Ark., and one at Donaldsonville, La., on the Mississippi, was established in June, 1890.

The gauge at Rock Island, Ill., was discontinued April 30, 1879, because observations so far upstream were no longer needed, and the gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, but readings at the latter place have been continued by the Missouri River Commission.

Observations commenced at each station as soon as the gauge was set up, and with a few exceptions, during the periods when no funds were available, have been continued regularly since. In 1881 bulletins were erected at stations on the Mississippi for the purpose of giving passing steamboats the stage of water at each reading, and showing whether the river was rising, stationary, or falling. The size of the plates in the original bulletins was 20¾ by 24 inches, black figures on white ground, but in 1890 they were replaced by larger bulletins, one-sixteenth inch sheet iron plates, each 40 by 48 inches, white figures on black ground, which are large enough to be read easily with the naked eye at a distance of half a mile. The old bulletins were repaired and used in extending the service to the tributaries. From 1871 to February 1, 1887, the gauges were read and bulletins changed at 8 a. m. daily, but since the latter date this has been done at 8 a. m. and 4 p. m. every day, and greater uniformity and accuracy have been secured by the change. The gauge readings are received at this office weekly and are reviewed, consolidated, and sent to the Secretary of the Mississippi River Commission, by whom they have been published to the end of the calendar year 1893.

Gauge staves are made in advance at Vicksburg and shipped when needed, a few sections being kept on hand at stations with caving banks or where the gauge must be set in an exposed place. They are of two sizes, the larger to be bolted to bridges, wharves, etc., and the smaller, for temporary service, to be driven into the bank at successive stages, rising or falling. Numbers and graduations in feet and tenths

are branded, thus saving time and money, giving uniform scales, and marks not easily obliterated.

The engineer gauges are used by the Weather Bureau at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., Vicksburg, Miss., Donaldsonville, La., Nashville, Tenn., Alexandria, La., Shreveport, La., and Fulton, Ark.

The present service consists of twenty-two gauges, located as follows, and at which observations were continued during the fiscal year ending June 30, 1894, viz: On Mississippi River at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., mouth of White River, Ark., Lake Providence, La., Vicksburg, Miss., Natchez, Miss., Red River Landing, La., Baton Rouge, La., Donaldsonville, La., and Carrollton (New Orleans), La.; on Ohio River at Louisville, Ky., head of falls and foot of falls; on Tennessee River at Florence, Ala.; on Cumberland River at Nashville, Tenn.; on White River at Jacksonport, Ark.; on Arkansas River at Little Rock, Ark.; and on Red River at Alexandria and Shreveport, La., and Garland and Fulton, Ark.

Records of the daily readings were furnished the president of the Mississippi River Commission; copy of the Florence record was furnished the engineer officer in charge of Lower Tennessee River; copy of the Carrollton record was sent the assistant engineer at South Pass of the Mississippi; copy of the Jacksonport record was sent the chief engineer of the Board of Mississippi Levee Commissioners; and district officers, levee commissioners, etc., were furnished copies of records at various stations upon application.

The gauge at Cairo, Ill., was rebuilt from the 9 to the 51 foot mark by the Weather Bureau in November, 1893.

The following gauges were inspected during the year by Assistant Engineer J. A. Ockerson, under direction of the secretary of the Mississippi River Commission, viz: October 17, Helena, Ark.; December 13, St. Louis, Mo.

During the progress of work on the survey of Red River the following gauges were inspected, viz: By Assistant Engineer G. C. Hayden, Alexandria, La., October 6. By Assistant Engineer T. C. Thomas, Fulton, Ark., August 21; Garland, Ark., September 13, and Shreveport, La., October 23.

Assistant Engineer John Ewens inspected the following gauges during the year, viz: February 8, Carrollton, La., gauge rebuilt from 0 to 13 foot mark and upper section reset; February 9, Donaldsonville, La.; February 10, Baton Rouge, La., gauge rebuilt from 8 to 25 foot mark and from 36 to 41 foot mark; February 14, Natchez, Miss., gauge rebuilt from 27 to 50 foot mark; February 16, Red River Landing, La., gauge rebuilt from 24 to 42.4 foot mark and high-water section repainted; February 22, Vicksburg, Miss., gauge rebuilt from 36 to 43 foot mark.

The following gauges were inspected by Assistant Engineer N. S. Williams, under direction of the secretary of the Mississippi River Commission, viz: January 11, Carrollton, La.; February 19, Donaldsonville, La.; March 10, Carrollton, La., and April 21, mouth of White River, Ark.

Assistant Engineer T. C. Thomas inspected the gauge at Alexandria, La., May 31, and rebuilt it from the 26 to 39 foot mark; and the gauge at Natchez, Miss., June 11, and rebuilt it from the 27 to 38 foot mark.

Comparison of flood of 1894 with highest water recorded since establishment of present gauges.

Gauge stations.	Year gauge was established.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean gulf level at Biloxi, Miss.*	Highest water previously recorded on present gauge.		Highest water during fiscal year ending June 30, 1894.		Relation to previous highest record.	
				Date.	Gauge reading.	Date.	Gauge reading.	Above.	Below.
		Feet.	*Feet.*		*Feet.*		*Feet.*	*Feet.*	*Feet.*
St. Louis, Mo	1871	400.23	378.97	May 19, 1892	35.95	May 11	23.67	.....	12.28
Cairo, Ill	1871	290.84	269.58	Feb. 27, 1883	52.17	Feb. 16	37	.....	15.17
Memphis, Tenn	1871	203.97	182.71	Mar. 23, 24; Apr. 4, 5, 1890.	35.60	Feb. 19, 20	29.20	.....	6.40
Helena, Ark	1871	161.98	140.72	Apr. 30, 1886	48.10	Feb. 21	38.07	.....	10.03
Mouth White River Ark.	1871	128.73	107.47	Mar. 31, 1890	50.40	Feb. 23	41.72	.....	8.68
Lake Providence, La.	1871	89.62	68.36	June 2, 1892	41.90	Feb. 25, 26	34.40	.....	7.50
Vicksburg, Miss	1871	66.04	44.78	Apr. 24, 25, '90.	49.05	July 1 Apr. 2	41.40 40.90	.....	8.15
Natchez, Miss	1871	36.89	15.63	Apr. 23, 1890	48.60	July 1 Apr. 3, 4	44.90 40.60	.....	8
Red River Landing, La.	1871	23.85	2.59	June 27, 1892	48.87	July 1 Apr. 5, 6	47.32 39.50	.....	9.37
Baton Rouge, La	1871	29.06	—1.20	June 28, 1892	38.45	July 1 Apr. 5	37.35 30.95	.....	7.50
Donaldsonville, La.	1890	†19.14	†—2.12	June 23, 1893	30.60	July 1 Apr. 5, 6	29 24.35	.....	6.25
Carrollton, La	1872	20.91	—0.35	June 22, 1893	17.45	July 1 Apr. 6	16.40 13.70	.....	3.75
Louisville, Ky. (upper).	1871	†419.76	†398.50	Feb. 16, 1884	46.60	Feb. 14	12.70	.....	33.90
Louisville, Ky. (lower).	1871	†392.85	†371.59	Feb. 16, 1884	72	Feb. 14	35.20	.....	36.80
Florence, Ala	1871	.....	.....	Jan. 22, 1882	29.60	Feb. 9	17.70	.....	11.90
Nashville, Tenn	1873	.....	.....	Jan. 22, 1882	55.30	Feb. 9	42.10	.....	13.20
Jacksonport, Ark	1871	.....	.....	Mar. 14, 1890	33.35	May 11	28.90	.....	4.45
Little Rock, Ark	1871	241.50	220.24	May 21, 1892	31.20	Mar. 22, 23	24.80	.....	6.40
Alexandria, La	1871	64.46	43.20	June 12, 13, '92.	38.25	Apr. 12	35.25	.....	3
Shreveport, La	1890	161.27	140.01	May 28, 1892	35.70	Apr. 2	34.50	.....	1.20
Garland, Ark	1890	223.44	202.18	May 24, 25, '92.	28.40	Mar. 24	28.50	0.10	.....
Fulton, Ark	1890	244.78	223.52	May 23, 24, '92.	34.85	Mar. 24	33	.....	1.85

* Mississippi River Commission preliminary value, 21.26 feet above Cairo datum plane.
† Preliminary value.

NOTE.—The highest readings during the fiscal year 1894 on the Mississippi from Vicksburg to Carrollton occurred July 1, 1893, the flood being then on the decline. As the highest readings of that flood were given in my last report (p. 2064, Report Chief of Engineers, 1893), the readings of July 1 are not considered in comparing the relation of high water of fiscal year 1894 with previous highest record.

Itemized statement of expenditures during the fiscal year ending June 30, 1894, submitted in compliance with requirements of section 6 of river and harbor act of 1888.

Observations:		
Pay of 21 permanent gauge-keepers from July 1, 1893, to June 30, 1894, inclusive	$3,660.00	
Inspections and repairs:		$3,660.00
Pay of assistant engineer, 8 months 11¼ days, at $150	1,258.75	
Traveling expenses of assistant engineer while inspecting gauges	49.50	
Pay of employés hired to assist gauge inspector and to repair gauges and bulletins	11.50	
Material for repair of gauges	30.60	
Transportation of material for repair of gauges	.85	
Office expenses and contingencies:		1,351.20
Pay of clerk, 3 months, at $90	270.00	
Stationery	20.38	
Hire of telephone	13.50	
Telegrams	8.94	
Proportion of expenses for precise leveling to gauges in connection with line from Vidalia to Monroe, La	183.33	
		496.15
Total		5,507.35

Outstanding liabilities July 1, 1894.

ıy of deceased gauge-keeper, St. Louis, Mo., July 1–17, 1890	$11.00
ıy of deceased gauge-keeper, Garland, Ark., January 1–31, 1892	10.00
Total	21.00

Money statement.

ıly 1, 1893, balance unexpended	$29.81
ıount allotted for fiscal year ending June 30, 1894	5,500.00
	5,529.81
ıne 30, 1894, amount expended during fiscal year	5,507.35
ıly 1, 1894, balance unexpended	22.46
ıly 1, 1894, outstanding liabilities	21.00
ıly 1, 1894, balance available	1.46
ıount allotted for fiscal year ending June 30, 1895	5,500.00
ıount available for fiscal year ending June 30, 1895	5,501.46
Amount that can be profitably expended in fiscal year ending June 30, 1896	12,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

APPENDIX W.

IMPROVEMENT OF ARKANSAS RIVER AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, CAPTS. CARL F. PALFREY AND H. S. TABER, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Removing obstructions in Arkansas River, Arkansas and Kansas.
2. Arkansas River, Arkansas.
3. Fourche Le Fevre River, Arkansas.
4. Petit Jean River, Arkansas.
5. White River, Arkansas.
6. Cache River, Arkansas.
7. Black River, Arkansas and Missouri.
8. St. Francis River, Arkansas.
9. St. Francis River, Missouri.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 12, 1894.

GENERAL: I have the honor to present herewith annual reports for the year 1894 of the following works of river and harbor improvement under my charge.

* * * * * * *

I have the honor to be, very respectfully, your obedient servant,
CARL F. PALFREY,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

W 1.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS AND KANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To remove (otherwise than by permanent works) obstructions to navigation.

Project.—Originally, to raise and destroy snags, cut overhanging timber, remove bowlders and reefs by blasting and dredging, and to cut out sand bars by temporary wing dams. The survey of the river

with a view to project for permanent improvement was included under this head.

Since appropriations for permanent improvement were made, blasting, dredging, and dams have been omitted from the project under this head, leaving the customary snagging operations only.

OPERATIONS OF THE FISCAL YEAR.

The snagging operations for this year were confined to the reach of river between Little Rock and Dardanelle, Ark., a distance of 87½ miles. The U. S. snag boat *Henry Sheldon* began this work at Little Rock, Ark., on November 17, 1893, working up to Palarm by the 27th. On account of a rise in the river the boat was returned to Little Rock, and advantage taken of the time to enlarge the rudders. On the 4th of December, the boat resumed operations and worked up to Hog Thief Shoal, arriving there January 3, 1894. On account of low water the boat could not pass over the shoals and the crew were engaged until the 13th cutting overhanging timber, when work was suspended until the 22d. A rise enabled the steamer to proceed up the river, but covered the snags; the overhanging timber in Hog Thief Bend was cut and the boat ran to Dardanelle, arriving there the 28th; was thoroughly cleaned and placed in the care of a custodian on the 30th of January. There were 387 snags removed, 1,346 trees cut, 1 drift pile destroyed, and 166¼ miles run by the steamer.

PLANT.

The snag boat *Beauregard*, the construction of which was begun in the fiscal year ending June 30, 1893, was practically completed; there yet remains a small amount of carpenter work to be done. The boat is 140 feet long, 28 feet beam, and 18 inches draft without fuel or supplies.

The plant held under this head has been, by authority of the Chief of Engineers, consolidated with that held for improving Arkansas River.

RESULTS OF THE WORK.

The Arkansas River has in the State of Arkansas about 370 miles of caving banks, much of which is of wooded ground. Its tributaries are also in general snaggy streams. The floods of the Mississippi set back upon its bed snags and logs drifting to that river.

The evidence of pilots is that the snagging operations have more than met the annual increase, and that the condition of the river in this particular is steadily and materially improving. The same evidence, as well as my own observation of 235.9 miles of river, is that these operations can not be diminished for many years yet, and could profitably be materially increased.

APPROPRIATIONS AND EXPENDITURES.

Appropriations for the work now carried on under this head have been made and work carried on under them intermittently since 1832. In the appropriations of 1842 to 1844, and in those of 1866 to 1878, operations on the Arkansas were combined with those on other rivers, without stated distribution of funds. For the latter series, I am indebted to Lieut. Col. C. R. Suter, Corps of Engineers, for a statement of the expenditures which he considers chargeable to the Arkansas

River; as the accounts were not kept separate, it is not given as absolute, but as a close approximation. Based upon this proportion, and allowing a little less, in view of the probable relative importance of the Arkansas in the forties, I estimate $80,000 as the allotment from the earlier series.

July 3, 1832 (less $38 carried to surplus fund)	$14,962.00
March 3, 1835	40,000.00
March 3, 1837	25,000.00
July 7, 1838 (less $1,115.66 carried to surplus fund)	38,884.34
From appropriations 1842–1844 (estimate)	80,000.00
August 30, 1852 (less $269.47 carried to surplus fund)	39,730.53
From appropriations 1866–1878 (disbursements reported by Col. Suter)	344,831.59
March 3, 1879 (part)	30,000.00
June 14, 1880 (part)	35,000.00
March 3, 1881 (part)	25,000.00
August 2, 1882	35,000.00
July 5, 1884	36,000.00
August 5, 1886	19,875 00
August 11, 1888	25,000.00
September 19, 1890	20,000.00
From sale of *Reese*	20,000.00
July 13, 1892	20,000.00
Total	849,283.46
Expended to June 30, 1893	829,328.57

Money statement.

July 1, 1893, balance unexpended	$19,954.89	
Received on account of sale of U. S. snag boat *Missouri*	2,500.00	
		$22,454.89
June 30, 1894, amount expended during fiscal year		21,882.05
July 1, 1894, balance unexpended		572.84
July 1, 1894, outstanding liabilities		135.94
July 1, 1894, balance available		436.90
Amount (estimated) required for completion of existing project, annually		35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Expense account.

Pay roll	$11,296.91	Telephone rent	$15.00
General supplies	1,318.58	Stationery	103.43
Subsistence	768.89	Capstans	1,225.00
Transportation	13.70	Boilers	2,600.00
Fuel	116.72	Machinery	2,750.00
Lumber	1,325.27	Reserved in Treasury United States, account freight charges	211.86
Telegrams	11.44		
Traveling expenses	23.25		
Water rent	17.00	Total	21,882.05
Office rent	85.00		

W 2.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To secure a navigable channel not less than 6 feet in depth

from Little Rock to the Mississippi River, via the White River C
and not less than 2 feet in depth above Little Rock.

Project.—Prior to 1886 works upon this river were special im
ments of detached reaches, generally with immediate reference t
fining the channel to draw spans of bridges, or to the water fro
towns having quays, and to the improvement of some especially
cult crossing.

The act which became law August 11, 1888, adopted the pla
forth in Appendix V 13, Annual Report of Chief of Engineers f
fiscal year 1885, and in House Ex. Doc. No. 90, Forty-ninth Con
first session (the former relating to the reach "from Little Rock
Mississippi River, via the White River Cut-off," the latter to the
from Fort Gibson to Wichita, Kans.), and authorized the appli
of available balances of former appropriations to this work, ad
as part of it the works already constructed under those appropri

These plans were for removal, by blasting and dredging, of roc
gravel reefs, contraction by permeable dikes as used on the Missi
River, or by brush and stone dams, no mention being made of
ment, except by implication in the references to the Mississippi
The works constructed under these appropriations by the offic
senting the plans show high permeable dikes, similar dikes
quently solidly filled with stone, low dikes originally built of
upon mattress foundations, brush and stone dams, and a spari
of revetment. Works of all these types were constructed and re
before the appropriation of July 13, 1892.

In view of the above action, the adopted project is to remov
and gravel reefs by blasting and dredging, to contract the chan
dikes or dams, permeable or solid, of such construction as th
conditions require, and to hold the channel so obtained by rev
where necessary.

PRESENT WORKS.

Above Fort Smith.—Near Holts Rock, on right bank, 18½ miles
Fort Smith, two brush and stone dikes, 400 feet and 500 feet; to
feet. Built in fiscal years 1891–'92. No repairs.

Cherokee Chute, on left bank, 12 miles above Fort Smith, o
meable dike 350 feet long. Built in fiscal year 1890. No repair

Poteau Reach, on left bank, one-half to 3½ miles above Fort
six dikes, 320, 450, 600, 420, 300, and 1,150 feet; built permeable i
years 1887–1890–'91 (total 3,240 feet). Four of these, 320, 450, 6
420 feet; total 1,790 feet; converted into solid stone-capped d
fiscal year 1893. Two, 300 and 1,150 feet; total 1,450 feet, still
able.

From Little Rock to Fort Smith.—At Van Buren, on right
187 miles above Little Rock, two solid stone-capped dikes, 900 a
feet; total, 1,500 feet. One dyke, 900 feet, was built for a r
incline; the other, 600 feet, was built permeable in fiscal yea
Both converted into solid stone-capped dikes in fiscal years 189

Moore's Rocks, 168 miles above Little Rock, one channel
wide, 425 feet long, to a depth of 2 feet at low water; excav
fiscal years 1891, 1893.

Dardanelle Reach, on left bank, 88 to 89 miles above Little
three solid stone-capped dikes 250, 200, and 140 feet; total, 59
One, 250 feet, built of riprap stone on brush mattress in fisc
1894; one, 200 feet, was built permeable in fiscal year 1887, con
into stone capped dike in fiscal years 1893, 1894; one, 140 feet,

boat wharf, broken near shore, converted into stone dike in fiscal
894.
stal Hill, on left bank, 11¾ miles above Little Rock, one solid dike,
et, built of riprap stone on brush mattress in fiscal year 1894
ished).
ove Baring Cross bridge, on right bank, 1¾ to 2¾ miles above
Rock, five stone dikes, 240, 150, 320, 135, and 150 feet; total, 995
Three of these, 240, 320, and 135 feet, built permeable in fiscal
1888, 1889, repaired in fiscal year 1892, and converted into stone-
d dikes in fiscal year 1893. Two, 150 and 150 feet, built of stone
ush mattress in fiscal year 1893; all repaired in fiscal year 1894.
m *Little Rock to mouth.*—Reach below Little Rock Junction
ay Company bridge, on left bank, no miles to 1 mile below Little
, four dikes 400, 260, 250, and 400 feet, built as permeable dikes in
year 1888–'89; converted into solid stone-capped dikes in fiscal
1893. Each dike was built 400 feet long, the two shorter dikes
filled to the remaining lengths of the original structures.
ads Point, on right bank, 1¾ miles below Little Rock, one perme-
like 200 feet long, built in fiscal year 1888. No repairs.
gle Bend, on left bank, 20½ miles below Little Rock, two permeable
, 600 and 394 feet, total 994 feet, built in fiscal year 1888. No
rs.
ite Bluff, on left bank, 43 miles below Little Rock, two permeable
, 200 and 400 feet, total 600 feet, built in fiscal year 1888. No
rs.
e Bluff Reach, on right bank, 65 to 67 miles below Little Rock, six
, 1,520, 400, 200, 150, 150, and 150 feet; total, 2,570 feet. One dike,
feet, built in fiscal year 1885, 400 feet of brush and sand-boxes and
feet permeable, repaired in fiscal year 1887, still permeable. Five
, 400, 200, 150, 150, and 150 feet, are now solid stone-capped dikes.
of these, 400, 200, and 150 feet, built permeable in fiscal years
1890, 1891. One, 400 feet, repaired in fiscal year 1892, and con-
d into solid stone-capped dikes in fiscal year 1893. Two, 200 and
eet, converted into brush and sand-box dikes in fiscal year 1891,
nto solid stone-capped dikes in fiscal years 1892, 1893.
e last two, 150 feet each, built of brush and sand-boxes in fiscal
1892, converted into solid stone-capped dikes in fiscal years
1894.
o bank revetments, 7,395 feet long in all. One, 2,115 feet, from
4 to Dike 6, built in fiscal years 1893, 1894; one beginning 600 feet
r Dike 6, extending downstream 5,280 feet, built in fiscal year
repaired in fiscal year 1894.
rgus Place Reach, on right bank, 68 to 69 miles below Little Rock,
permeable dikes, 450, 800, 800, and 807 feet; total, 2,857 feet. Built
cal year 1891, repaired in fiscal year 1892. One, 450 feet, repaired
cal years 1893, 1894 by stone filling.
b Roy Reach, on right bank, 73¾ miles below Little Rock, one per
le dike, 1,200 feet long, built in fiscal year 1891. No repairs.

OPERATIONS OF THE FISCAL YEAR.

ove *Fort Smith.*—None.
om *Little Rock to Fort Smith.*—Right bank, near Van Buren;
1-12, conversion of old permeable dike into solid, in progress at
ning of year, completed; 693¼ yards riprap stone used, making
yards for this dike.

Left bank, near Dardanelle.—July 1–September 2, conversion o permeable Dike Y into solid, of riprap stone, 200 feet long, 7 feet above low water, in progress at beginning of fiscal year, complete

September 4–December 28, construction of new Dike X, solid, o rap stone, 250 feet long, 7 feet high above low water, 6 feet wide on on brush mattress 60 feet wide, with bank revetment to high wat root of dike.

November 7–December 1, conversion of old stone wharf into dike by filling break near shore, giving a dike 140 feet long.

The stone used in the work was obtained by hired labor from a qu 1½ miles above old Dike Y. The U. S. snag boat *Wichita* was use tow the stone to the dikes until July 29, when, on account of the l water, the boat could not be used for this purpose, and cordeling resorted to. The brush was procured by hired labor from lands a 3½ miles above old Dike Y. Low water greatly retarded the pro of the work. A bar in front of the quarry prevented getting b very close. During part of the time the stone had to be wheeled feet across it. A long, shallow crossing between the quarry and dike interfered with cordelling and made light loads on the barges essary. The *Wichita* remained here until August 22, under repairs to machinery and boilers, which, being completed, the ste was transferred to Pine Bluff.

Statement of material used in the work near Dardanelle.

Nature of material.	Old Dike Y.			Old wharf, fiscal year 1894.	Di fisc
	Fiscal year 1893.	Fiscal year 1894.	Total.		
Mattress.....square feet..	5,100	.....	5,100	.....	
Stone.....cubic yards..	552	2,193	2,745	812	
Brush.....cords..	60	.....	60	.....	
Rope.....pounds..	600	.....	600	.....	
Nails.....do.....	150	.....	150	.....	

Upon the completion of this work the fleet was floated to the Maumelle Reach.

Left bank at Crystal Hill.—January 19–March 10, constructi solid dike of riprap stone, 300 feet long, 7 feet high above low wa feet wide at top, on brush mattress 60 feet wide, with bank revet at root of dike, nearly completed when work was suspended on ac of high water. The dike was left of nearly full mass but rough; 1 200 yards of stone may be required to complete it and rectify form

In the approved project of my predecessor, two dikes (E and F) contemplated, 1,500 feet apart. As it was late in the season bef fleet became available and the high-water season near at hand, onl construction of Dike E was undertaken. The brush required fo mattress was procured by hired labor from Rectors Island, just a Crystal Hill; the stone was purchased in open market at three r 2,193 cubic yards, at 75 cents per cubic yard, on the barge at Cr Hill; 656 cubic yards, at 60 cents per cubic yard, on the bank at Cr Hill; and 108 cubic yards, at 16 cents per cubic yard, at the Ives P about 3½ miles above Crystal Hill. The foundation mattress was 350 feet long by 60 feet wide, but a rise shifted the outer end so th became necessary to weave a second mattress 145 feet long by 60 wide, making in all 495 linear feet, or 29,700 square feet. A second which began on the 9th of February, caused a temporary suspensi

work until the 21st of the month. The dike was out about 60 feet at this time and the eddy caused caving just below the dike, making it necessary to do some extra work at this point. No towboat was employed in the work.

Statement of material used in Dike E, Little Maumelle Reach.

Mattress	square feet..	29,700
Stone	cubic yards..	2,957
Wire	pounds..	1,987
Nails	do	150
Brush	cords..	336½
Rope	pounds..	300

At the completion of the work the fleet was floated to Little Rock.

BELOW LITTLE ROCK.

Left bank, near Little Rock.—November 1–February 28, conversion of old permeable dikes Nos. 1, 2, and 3 into solid dikes continued.

When work was suspended on this series of dikes in the fiscal year ending June 30, 1893, Dike No. 1 had been solidified to only 170 feet, Dike No. 2 to 260 feet, and Dike No. 3, 250 feet, these being the remaining lengths of the original 400 feet each.

An examination of the dikes after the high water of 1893 showed that the bank immediately below Dike 3 had caved and the riprap on that side gone. A deep hole was also found just below the dike, causing a portion of the dike 50 feet from the bank and about 40 feet in length and one-half the width of the dike to slide. Dike No. 1 was extended to its original length, 400 feet.

The shore ends of the dikes Nos. 1, 2, and 3 were raised and the riprap strengthened. The hole below Dike No. 3 was filled, and that part of the dike where the slide had occurred was repaired. The dikes on right bank, above the Baring Cross bridge were also strengthened. There were used in the work 3,155 cubic yards of stone in the dikes below the Little Rock Junction Railway bridge, and 60 cubic yards of stone in Dike A', above the Baring Cross bridge. No towboat was available for this work and the stone was transported to the dikes by cordelling, excepting 260 cubic yards which were towed by the U. S. towboat *Cleveland* just at the close of the work. Dikes 2 and 3 yet remain to be restored to the original length.

Right bank, near Pine Bluff.—July 1–November 28, construction of revetment between dikes 5 and 6, and repairs to Dike A°, in progress at beginning of fiscal year; also repairs of revetment below Mallory's Ditch, and conversion of old brush and sand-box dikes 5 and 6 into solid dikes of riprap, each 150 feet long, 17 feet high above low water, of width varying to conform to original construction, completed, except repairs of Dike A°, suspended on account of lack of funds.

The brush used in the work was purchased in open market, delivery being made on barges in the vicinity of Pastoria and Rob Roy bridge. Four thousand nine hundred and nine cubic yards of the stone used were purchased in open market, delivered on the river bank in the vicinity of Pine Bluff; the remainder was stone that had been barged to Pine Bluff during the previous year. The U. S. towboat *Cleveland* was used for towing (with the exception of one week) until November 18. The low water interfered greatly with the towing of brush.

Statement of material used in construction work at Pine Bluff.

	Revetment between Dike 5 and Dike 6.			Repairs to Dike A.			Repairs to revetment below Mallory's Ditch.	Reconstruction of Dike 5.	Reconstruction of Dike 6.
	Fiscal year.		Total.	Fiscal year.		Total.	Fiscal year.		
	1893.	1894.		1893.	1894.		1894.	1894.	1894.
Mattress, woven, square feet	91,175	138,075	229,250				15,200		
Brush used.....cords..	324	590	914	122	35	157	77	752½	507
Stone sinking mattress, cubic yards	328	514	942						
Stone riprapping bank, cubic yards	142	872	1,014	756	540	1,296	122	2,818	3,056
Poles.....number..	979	1,515	2,494	357	37	394	220	1,650	957
Wire.....pounds..	1,775	2,650	4,425	545	50	595	500	3,281	1,925
Nails.....do....	440	460	900	205	0	205	55	485	290
Sand boxes.....number..									100
Mooring piles.....do....	11	0	11						

Also 1,191 pounds rope used in the whole work.

At Big Rock, 3.8 miles above Little Rock.—At the beginning of the fiscal year there was a force employed here quarrying stone. The U. S. snag boat *Henry Sheldon* had been towing it to Pine Bluff, but became totally disabled on July 3, and quarrying was suspended on July 28. In the meantime 550 cubic yards of stone were quarried. During the months of August, September, and October the fleet remained at Big Rock in the care of a custodian, necessary repairs being made to the quarter boat and barges.

In all, 2,650 yards were quarried during the year, some being on hand at its beginning.

Three thousand one hundred and fifty-five yards were used in dikes opposite Little Rock; 168 yards on dikes near and above Little Rock; 120 yards shipped to Pine Bluff, of which 30 yards were lost.

PLANT.

At Little Rock, Ark.—At the beginning of the fiscal year a pile-driver barge 74 by 20 feet was under construction. This was completed the first week in August. A new hull for the U. S. towboat *Cleveland* was begun on October 23, 1893, and launched on November 24. The old cabin was hardly in condition to bear removal. A cabin was built on the new hull, using all available material from the old, of which there was little but doors, frames, and sashes. The machinery was transferred from the old to the new hull and the boat put to work on February 20, 1894. Excepting the machinery, the boat is now practically new, is 100 feet long, 20 feet wide, and draws 17 inches without fuel. The old hull, with sides and roof of cabin, remains available for the present for storage. General repairs were made to barges.

The plant held under appropriations for "Removing obstructions in Arkansas River, Arkansas and Kansas," and for works on tributaries of the Arkansas, has, by authority of the Chief of Engineers, been transferred to this head.

CHANNEL.

In reporting upon the channel and the effect of the works in 189[illegible] *present* hearsay information. During my charge I have not had

mission boats available for inspection trips nor funds sufficient to
ify such use of them. Opportunities for travel by public convey-
e have not been frequent, and those of which I have been able to
il myself have not been at such stages of water as to afford the
st valuable information.

Above Fort Smith, as far as Webbers Falls, 61½ miles by river,
ich has been the reach navigated in 1894, the chief difficulties met
at Choctaw and Cherokee Chutes, and Bruces Island, 12 miles
ve Fort Smith, and a shifting bar just above the mouth of Poteau
er, which is dangerously near the draw span of the railway bridge.

A dike was built in 1890 across the Cherokee Chute, nearly or quite
sing it, about 2,500 feet below its head, and 1,600 feet below the
uth of Skin Bayou, which opens into this chute. It was intended
throw the river into Choctaw Chute. Although the Choctaw Chute
s not always been open, it would appear from its length and align-
nt to be the more natural course of the river.

The work has not been successful. A deep cut has formed across the
and end of the dike in Cherokee Chute, and the flow through Choc-
w Chute has developed a reef, reported as apparently of bowlders,
ross that chute, which makes navigation difficult.

In my only examination, which was made at a stage of 10.4 feet, I
ent up the Cherokee Chute around the dike by steamer and came
wn the Choctaw Chute by skiff. It appears probable that just below
e bold rocky point on the left bank, known as Wilsons Rock, there
a submerged reef from the right bank, which throws the current
way from the Choctaw Chute and into the Cherokee Chute.

At suitable stage, examinations and careful soundings will be made
determine this point and the nature of the reef in Choctaw Chute.
t the time of Abert's survey, 1869, Choctaw Chute was dry; survey
1889 indicated the deeper natural channel in the Choctaw side; sub-
quent survey has been made of the Cherokee Chute only.

The shifting bar above the mouth of Poteau River depends upon the
age of the two rivers and the effect of the Poteau upon the current
the Arkansas. In 1869 the mouth of the Poteau was formed by a
int of rock on the downstream side, tending to throw the current
ainst that of the Arkansas, and a mud point on the upstream side
erlapping the former and turning the stream down the Arkansas.
e river has cut away so much of the mud point that the rock point
ntrols the direction of the Poteau at its junction, and the meeting of
e opposing currents produces the bar. At a suitable stage, exami-
tion will be made with reference to cutting away this point of rock
d reenforcing the mud point with the material excavated, so as to
store the former condition and remove the cause of the bar.

FROM LITTLE ROCK TO FORT SMITH (194.3 MILES).

In this reach 27 shoal crossings are reported, of which 19 are ordi-
ry channel crossings, 7 are shoals from 2 to 4 miles in channel dis-
ce, and 1, the cut at Moores Rock, a passage difficult because of
narrowness of the cut and of the line of approach to it from
stream.

In this reach there are 43.5 miles in which the river is, on one bank
he other, close against mountain or rock. In the 63 miles, which I
e passed over by daylight, I have note of 11.17 miles of rocky bank
of 27.65 miles of bank badly caving. One reach of nearly 5 miles

river is known to me in which, without mountainous banks, no active aving is in progress. I estimate the development of bank which akes annual contributions to sand bars and snags at 180 miles.

ROM LITTLE ROCK TO MISSISSIPPI RIVER, VIA WHITE RIVER (173.4 MILES).

In this reach there are few bluffs, none of which is rocky. There is ardly a recognizable straight reach of river between one bend and ie next. I have seen by day or search light 148.6 miles of this reach, a moderately high stage, in which caving was always evident on ie bank or the other, with some little overlapping in the short turns. he crossings have very generally shifting middle grounds, but the terest of the pilots was chiefly manifested in the snagging opera- ons. I estimate the caving bank of this reach at 10 per cent more an its length, or about 190 miles. Much of this caving is of valu- ble cultivated land; that at Red Fork and that near Cummings Land g endanger levees; about one-third is chiefly important for its addi- ons to bars and snags.

A somewhat curious cut-off has taken place in this reach. About 25 iles below Little Rock was a point on the left bank which had for a ile and a half of axial length a nearly uniform width of one-half mile. he river has cut across this point at less than half a mile from its tip, id the cut is reported as widening at the expense of the island.

COMMERCE AND TONNAGE.

The commerce of the river follows, with little overlapping, the divi- ons of the appropriation bills. The river traffic of the section above ort Smith centers at that city, which also draws upon the lower river far as Dardanelle. The traffic on the section from Little Rock to ort Smith is by lines of steamers owned at Little Rock and running so to Pine Bluff. The principal traffic from Little Rock to the mouth by a line of steamers running from Pine Bluff to Memphis.

The Arkansas River is paralleled on the north side, from Fort Gib- n, Ind. T., to Swan Lake Landing, Ark., by the following railroads: ort Gibson to Fort Smith, by the Kansas and Arkansas Valley; Fort mith to Van Buren and Little Rock, by the Little Rock and Fort mith Railway; Little Rock to Rob Roy, by the Little Rock branch of ie St. Louis Southwestern Railway; Rob Roy to Swan Lake Landing, the Pine Bluff and Swan Lake Railway. At no point are these ilroads over 12 miles from the river. On the south side of the river, om Little Rock to Douglas Landing, the Little Rock, Mississippi iver and Texas Railway lies within 6 miles of the river. The river crossed at Fort Smith by the Kansas and Arkansas Valley Railway; Van Buren by the Texas branch of the St. Louis and San Francisco ailway; at Little Rock by the St. Louis, Iron Mountain and Southern ailway, and by the Little Rock Junction Railway, and at Rob Roy by ie St. Louis Southwestern Railway.

The principal traffic is in cotton (plantation bales), cotton seed, rough mber and logs (hard and soft woods), brought to the three centers ove mentioned, and provisions and general merchandise carried out ence. From all the centers the finished products, pressed bales, oil, nished lumber, barrel staves, etc., are generally sent out by rail.

The tonnage of the past year is less than that of many recent years,

probably because of short crops and of the general business depression.

In comparing the present business with the traditional prosperity of steamboating, I find the usual changes of Western navigation. In the decade 1850–1860 steamers of from 800 to 1,200 tons plied from Little Rock to New Orleans, and steamers of from 600 to 800 tons from St. Louis to Fort Smith. The latter round trip took one month, and six were made in a good year. In the latter half of the decade 1860–1870, with the revival of industries, the river navigation was resumed with boats of 400 to 700 tons running from Little Rock to St. Louis, Cincinnati, and Memphis. Shortly after 1870 the general consolidation and improvement of the railroad system brought a serious diminution of river traffic.

Prior to 1860 the steamers had nearly a monopoly of freight and passenger traffic. They ran at great expense, using high-power engines, carrying large crews, well paid in the higher grades, and incurring heavy bills for repairs. They charged correspondingly high rates for freight and passage. From 1866 to 1870 they had still ample business, as the State of Arkansas was then less than now in touch with the great commercial centers of the country, and its local business centers were the more important thereby. Since 1870 the consolidation of railroad systems, and the change of business methods resulting therefrom, leave to the water transportation its usual function when in full competition with rail, the carriage of bulky and heavy rough products, and the general service of the river towns. This it is not likely to lose, and of this there is prospect of ample development.

Report of Mr. P. R. Van Frank, jr., assistant engineer, and letter of Mr. Ferd. Hamilton, containing details of the earlier navigation, are appended.

APPROPRIATIONS AND EXPENDITURES.

Prior to 1886 appropriations were for special works. The act of August 5, 1886, appropriated for the whole river, making allotments for certain of these works. The act which became law August 11, 1888, adopted these works and authorized the application of their balances to the general improvement.

The appropriations thus expended for works embraced in the present project are as follows:

June 14, 1880 (Pine Bluff)	$25,000.00
March 3, 1881 (Pine Bluff)	23,000.00
August 2, 1882 (Pine Bluff)	20,000.00
July 5, 1884 (Pine Bluff)	55,500.00
July 5, 1884 (Fort Smith)	5,000.00
August 5, 1886	75,000.00
August 11, 1888	150,000.00
September 19, 1890	180,000.00
July 13, 1892	250,000.00
Total	783,500.00
Expended to June 30, 1893	673,788.24

(The balance unexpended July 1, 1893, in this report differs from that of my predecessor for June 30, 1893, by an excess of $150. This is correction of an error of record made in 1890, affecting the reports 1891–1893.)

Money statement.

July 1, 1893, balance unexpended	$109,711.76	
Received on account of sale of U. S. quarter boats *Yorktown* and *Greenwich*	5,000.00	
		$114,711.76
June 30, 1894, amount expended during fiscal year		98,835.83
July 1, 1894, balance unexpended		15,875.93
July 1, 1894, outstanding liabilities		479.68
July 1, 1894, balance available		15,396.25
Amount (estimated) required for completion of existing project		3,222,479.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Expense account.

Pay roll	$57,667.11	Flags	$9.90
General supplies	5,439.89	Medicine	58.00
Subsistence	11,810.49	Office rent	340.00
Transportation	100.23	Telephone rent	85.00
Rock	14,578.51	Telegrams	71.25
Fuel	1,572.34	Telephone messages	8.37
Traveling expenses	327.60	Registry stamps	8.00
Piling, brush, and poles	4,176.09	Reserved in U. S. Treasury for freight charges	1,038.26
Lumber	1,238.87		
Mileage	186.00	Total	98,835.83
Stationery	119.92		

REPORT OF MR. P. R. VAN FRANK, JR., ASSISTANT ENGINEER.

LITTLE ROCK, ARK., *June 28, 1894.*

CAPTAIN: I have the honor to submit the following report of steamboating on the Arkansas River before the days of railroads:

The Press Directory of city of Little Rock (issued 1890) states that on March 19, 1822, the first steamboat arrived at Little Rock, and about the year 1825 a steamboat passed up the river to an Indian mission. Hempstead's History places the date of the first arrival as January 24, 1828, at which time the *Facility* came. This steamboat made the Arkansas River her home, and ran between Little Rock, Louisville, and New Orleans. In 1829 the steamboat *O'Hara* made occasional trips from Louisville with supplies for Cantonment Gibson, exchanging freight at Pine Bluff with the *Waverly* during low-water season. In this year the *Waverly* made the round trip between Little Rock and New Orleans in a few hours over twenty days. In 1830 there were 5 regular Arkansas River boats. This was a year of much immigration, and as many as 4 steamboats a day landed at Little Rock.

In 1832 the steamers *Little Rock* and *Arkansas* were built especially for the Arkansas River. In August, 1834, Capt. H. M. Shreve brought the first snag boats into the river. There were now 9 regular Arkansas River steamboats (1). In 1838 or 1840 large steamers made nine successive trips to Fort Gibson (2). In 1841 the *Arkansas*, a side-wheeler, made six successive trips from New Orleans to Fort Gibson, drawing not less than 6 feet (3).

Of the large boats that came into this river during the forties may be mentioned the *Robert Morris, Louisa, Mountaineer, Clipper, Cottonplant, Arkansas No. 4, Arkansas No. 5, Wing and Wing, Corvette, Siam,* and *Phillip Pennywit,* varying from 500 to 650 tons. These were all New Orleans boats, and were here only one season each, excepting the *Cottonplant,* which was here three seasons; the *Arkansas No. 4* and *Arkansas No. 5,* two seasons (3).

From December, 1852, to December, 1853, there were 27,900 tons of freight and 2,380 passengers brought to Little Rock by steamboats, and 17,000 bales of cotton shipped from above Little Rock (1). This was a low-water year (2). In 1855 the *Belle Gates* (200 feet long, 34 feet beam, 850 tons), the *Morrisette*, the *New World* (190 feet long, 33 feet beam, 800 tons), and the *Lucy Robinson* lay up about a year at Racine, Sarassa, Browns, and Lewisburg, respectively, on account of low water. The *Morrisette* and *Lucy Robinson* were about the same size as the *New World*. The owner of the *Belle Gates* rented a plantation and raised a crop with his crew while laying up. These boats made only the one trip. During this year there were eight months in which only 1 steamboat was landed at Little Rock. This was a small stern-wheeler named the *Red Rover*, drawing about 12 inches of water (3). In 1857-'58 the steamer *Thirty-fifth Parallel* (215 feet long, 33 feet beam, 750 tons), drawing 4 feet light, was detained at McCleans Bottom nine months on account of low water. Of the other boats of the fifties may be mentioned *Judy Touro* (200 feet long, 34 feet beam, 850 tons), during the seasons 1852-'53, and the *Franklin Pierce* (500 tons) during 1854. The *Sky Lark* (220 feet long, 36 feet beam, 950 tons) made two trips in the year 1859, being detained three months on one trip at a crossing, which, since that time has been called Sky Lark Crossing (3 and 4). During the latter part of the fifties there were 33 regular Arkansas River steamboats in the trade, and an occasional tramp steamer.

The year 1860 began with low water. The steamer *Sam Kirkman*, drawing 4½ feet, entered the Arkansas River in January, and, although she took advantage of every rise, did not reach Fort Smith until May (3). In 1861 for three months there were not over 12 inches of water over Dardanelle Shoals. In 1862 the water was so low that boats drawing 12 inches could not go from Little Rock Wharf above the point where Baring Cross bridge now stands. Just below Little Rock the river was divided into many small channels with not over 10 or 12 inches (4). In August, 1865, the *Importer*, drawing 4 feet, was caught near Ozark by the low water and did not get out until April, 1866 (3). In January, 1868, the *Silas Wright*, a very small steamboat, could not pass over Moores Rocks (2 and 3). Her freight was hauled from there to Van Buren and Fort Smith in wagons (3). With the closing of the war steamboating revived rapidly, and from 1867 to final decline there were 4 regular New Orleans, 13 regular Memphis, 6 Cincinnati, and 8 regular St. Louis steamers in the trade (3).

Of the "after-the-war" steamers may be mentioned the *Pat Cleburne* (212 feet long, 34 feet beam, 750 tons) and *Arkansas Belle* (212 feet long, 33 feet beam, 650 tons), regular Little Rock and Memphis; the *Mary McDonald* (225 feet long, 38 feet beam, 800 tons), *Peter Balen* (230 feet long, 38 feet beam, 775 tons), *E. O. Stanord* (200 feet long, 40 feet beam, 900 tons), and *Rudolph* (185 feet long, 38 feet beam, 700 tons), regular St. Louis; the *Fannie Tatum* (210 feet long, 36 feet beam, 750 tons) and *Katie P. Kounts* (220 feet long, 38 feet beam, 800 tons). The last two boats were in the St. Louis, Little Rock, and New Orleans trade (3).

The average size of the best Arkansas River steamers was 300 to 450 tons, and as a general thing could run six months each year. The St. Louis steamers usually made six rounds trips, taking about one month for each. The large New Orleans steamers made one to four trips, according to the cotton crop (3, 4).

The seasons of navigation were generally as follows: During the winter months and the period of the June rise, steamers of 700 tons could reach Fort Smith Landing. Then, as now, the duration of floods was uncertain. The regular boats below Little Rock drew from 5 to 6 feet; between Little Rock and Fort Smith, about 3½ feet. Between Fort Smith and Fort Gibson the regulars were little boats drawing 1 foot light. When navigation was open to Little Rock, boats could easily reach Dardanelle, a slight increase of water enabling them to reach Van Buren. About the 1st of September steamboat navigation above Fort Smith was suspended; at the same time the Beaver Dam, 23 miles above Little Rock, began to trouble Little Rock and Fort Smith steamers. About the middle of October small steamers had difficulty in reaching Fort Smith. Steamboat navigation was suspended above Fort Smith for about eight weeks, and for five weeks no steamboats would go above Dardanelle (2).

When no steamboats were running keel boats were used. With these a round trip between Little Rock and Fort Smith was made in twenty days, and between Fort Smith and Fort Gibson in nine days, everything being favorable. The keel boats were generally of 50 to 55 tons capacity and run at an expense of $450 per month. The cost of them, including the horses, was from $2,000 to $2,500. They were used during low-water seasons until the building of the Little Rock and Fort Smith Railway (4).

The decline of Arkansas River steamboating began early in the seventies, after the St. Louis, Iron Mountain and Southern, Little Rock and Memphis, and Little Rock and Fort Smith Railways were completed. Memphis boats of 200 to 400 tons ran regularly in the Little Rock trade until the completion of the Little Rock, Missis-

sippi River and Texas Railway late in 1880. This traffic now stops at Pine Bluff. In 1885 the steamboating below Pine Bluff had dwindled down to one steamer, making two trips a week, and between Pine Bluff and Little Rock a 200-ton steamer was making about the same number of trips. These boats seemed to supply the demand.

Regarding the filling in of the river bed. Years ago in the Galla Rock reach there was a pile of rocks (about 50 feet across) that was exposed at low water. In 1867 the *J. S. Hall* made 51 trips to Fort Smith (drawing 3 feet). Part of the time these rocks were 1 foot above water; now they are barely dry at lowest water (3 and 4). At the mouth of Fourche Le Fevre there is a reef of rocks extending about 200 feet from bank. These were exposed 2 feet at low water. The steamer *Violet* in the year 1856 was caught on this reef, and the river falling left her dry for six weeks. Water had to be carried to the boat for the use of the crew. The other Fort Smith steamers were running regular trips all this time. The present low-water channel is directly over this reef (3 and 4). In 1869 the *Cheyenne* went to Fort Smith, drawing 5 feet, and the top two wharf logs at Little Rock were out of water (3). (This corresponds with 7.7 feet on the signal-service gauge.) The U. S. snag boat *Wichita*, with three barges, greatest draft 19 inches, left Little Rock for Fort Smith on September 30, 1892, and did not reach Dardanelle until October 18. The signal-service gauge at Little Rock read 6.2 feet October 1; the river fell to 5.5 feet on October 17, then began rising (official records).

Excepting the U. S. snag boat *Macomb*, the largest boats that ever came up this river as high as Little Rock were the *T. P. Leathers* (225 feet long, 36 beam, 1,000 tons), *Platte Valley* (230 feet long, 36 feet beam, 1,000 tons), *J. H. Johnson* (267 feet long, 44 feet beam, 1,400 tons), *A. J. Lockwood* (250 feet long, 40 feet beam, 1,200 tons), *J. S. Pringle* (240 feet long, 44 feet beam, 1,300 tons), and *Exporter* (210 feet long, 49 feet beam, 1,200 tons). All excepting the last named were in the Government service as transports and made only one trip each, some time during or just at the close of the war (3 and 4).

The largest trip out of the river is that of the *Exporter* in 1873. This boat left Fort Smith with 600 bales of cotton (3), passed Little Rock April 11 with 4,803 bales (5), and left the river with 5,313 bales (3).

Mr. Fred Kramer (president of the Bank of Commerce, Little Rock) states that the freight rates were 75 cents to $1 per 100 on general merchandise from Cincinnati, and 40 to 75 cents per 100 from New Orleans. Mr. D. G. Fones says the $1 rate from Cincinnati was in force until 1870, then it dropped to 50 cents.

The cotton rate to New Orleans was $2 to $3 per bale (3). In 1867 the steamer *Fort Smith*, James Bowlin, master, received $2 per 100 on general merchandise to points above Little Rock, and $8 per bale on cotton to New Orleans.

NOTE.—For the statements numbered 1 I am indebted to Hempstead's Pictorial History of Arkansas; 2, to S. T. Abert's Report on Survey of Arkansas River; 3, to T. J. Griffy; 4, to Ed. Huston, and 5, to the Arkansas Gazette. S. T. Abert was assistant engineer in charge of survey of Arkansas River from Fort Gibson to Little Rock in 1869. T. J. Griffy was first on the Arkansas River in 1841, accompanying his brother-in-law, who was owner of the steamer *Arkansas*. He began studying piloting in 1848 or 1849. Ed. Huston came onto the Arkansas River in 1856 as keel boatman between Little Rock and Fort Gibson.

I had hoped to be able to get some definite information as to the number of boats lost in this river. The Gazette, April 5, 1872, published a list of 117 names. Griffy says that in 1879 he and a pilot named McNett made up a list containing about 170 names.

Very respectfully, your obedient servant,

P. R. VAN FRANK, JR.,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

No navigation above Webbers Falls was reported. The river was navigable to this place all of June, part of July, part of August, part of October, November, and December, 1893; part of January, and all of February, March, April, and May, 1894. Bruces Island was the head of low-water navigation.

List of boats engaged in navigating Arkansas River, June 1, 1893, to May 31, 1894.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Ft. in.	*Ft. in.*			
Wm. Druhe, No. 2*	Stern-wheel	179.18	1 2	3 6	Fort Smith and Webbers Falls.	63	1,034
					Fort Smith and Dardanelle.	10	
G. W. Mayo	....do	124.66	1 0	3 0	Fort Smith and Dardanelle.	1	10
					Fort Smith and Red Land.	1	
Eli*	....do	120.25	1 4	3 0	Little Rock and Dardanelle.	21	.....
Border City*	....do	88.86	1 1	3 0	Limits of trip not stated.	40	.....
City of Little Rock	....do	219.08	1 4	4 6	Little Rock and Dardanelle, Roseville, Cross Landing.	28	610
New Mary Morgan*	....do	67.62	1 2	2 6	Little Rock and Pine Bluff.	4	255
					Pine Bluff and below	15	
					Little Rock and Dardanelle.	12	
					Little Rock and mouth of Petit Jean.	1	
					Little Rock and mouth of Fourche.	8	
Rees Pritchard	....do	196.20	1 6	3 6	Little Rock and Pine Bluff, Fort Smith, Dardanelle.	38	†2,500
Eugene	....do	568.85	1 8	5 0	Memphis and Pine Bluff.	48	1,291

*With barge. †Probably includes excursionists.

The steamer *City of Little Rock* was built last year at New Albany, Ind., for the Little Rock and Fort Smith trade. There is a probability that another boat will be placed in the local Little Rock trade this fall.

Summary of commerce reported, June 1, 1893, to May 31, 1894.

Articles.	Tons.	Articles.	Tons.
Staves	250	Provisions	4,647
Cotton	7,213	Grain	3,185
Cotton seed	38,310	Miscellaneous freights	5,784
Hides and skins	31	Saw logs (rafted)	1,240
Live stock	287		
Lumber	2,616	Total	63,563

LETTER OF MR. FERD HAMILTON.

LITTLE ROCK, ARK. (No date).

Capt. PALFREY: Mr. Fred Hanger has informed me of your desire to learn something from practical steamboat men of the water in the Arkansas River; the steamboats, tonnage, etc., that plied on it in years gone by. Mr. Hanger, perhaps, came to me from the fact of his knowledge of my familiarity with the river since 1856 as a pilot; and I presume you seek data as to depth and bottom, such as only practical observation can present, which I shall state to you as succinctly and directly as possible.

There is no question in my mind as to the filling up of the bed of the river, presumably from the caving in of the banks and the broadening of the stream thereby. Boats that now ply the river in high water could not stem the current around points like White Bluff twenty-five years ago, and were forced to lay to during a rise and wait for the water to go down. In front of Little Rock the river to-day is more than twice as wide as it was twenty-five years ago, and comparatively of less depth. It is from one-third to one-half wider from here to the mouth than it was at that time.

In 1879 the steamer *Hattie Nowland* struck a log in the middle of the river, almost in front of the oil mill, and sunk. She was afterwards raised, but the log has never

een brought to the surface. It was embedded in the gravel, and the fact that it as never been seen since is palpable evidence that it is buried by the filling in of he bottom of the river. The *Nowland* at the time, was light, and drawing 28 to 30 nches when she struck.

As to boats in the river: In the fifties the steamers *Judy Touro, Pelican, Lucy Robinson, New World,* side-wheelers; the *Tennessee Belle, Quapaw, Julia Roan,* stern-wheelers, with from 400 to 600 tons capacity, plied regularly from New Orleans, frequently going as high up the river as Fort Smith. The side-wheel boats would raw from 6 to 7½ feet when loaded, and the stern-wheelers 1 to 2 feet less.

In the same years the *Hickman* and the *Henry Fitzhugh* were in the trade from Cinnati to Fort Smith. The first named was of about 600 and the latter 400 tons apacity. A number of other boats were transiently in the trade during these years, ut these were regular steamers.

In 1859 Maj. John D. Adams inaugurated the Memphis and Arkansas River Mail 'acket Company with the steamers *S. H. Tucker, South Bend, Little Rock,* and *Rose Douglass,* making a triweekly line to Little Rock. The boats were of 200 to 300 ons capacity.

The war coming on shortly, this line lapsed, but was revived in 1865 by Capt. Dan able, present harbor master at St. Louis, with the steamers *Centralia, Guidon,* and *Zephyr,* with a tonnage of 200 to 300 capacity.

In 1867 Maj. John D. Adams resumed control of the line, with the *Centralia, Celeste, Thos. H. Allen,* and *Mary Boyd,* afterwards bringing into the trade the side-wheelers *Pat Cleburne* and *Arkansas Belle.* These side-wheelers had a draft of 3 to 3½ feet ight, with capacity of 500 tons loaded. They were sold to the Cairo and Evansville Packet Company, after several years' service in this river.

During these years the following boats were regularly in the St. Louis and Arkansas River trade: *Utah, Sallie Rudolph, Minnie, Columbia, Last Chance, J. G. Blackford,* carrying from 400 to 800 tons. And in the same years from Cincinnati came he *Cora S., Bertha, Mary Ervin, J. H. Gilmore, Nannie Byers,* and others in the Cinnati and Arkansas River trade, having a capacity of 400 to 700 tons.

This river traffic continued until 1871, during which time Little Rock was practially the depot of supplies for the entire State and a large portion of Texas. In that ear the Iron Mountain bridge was completed and the river business began to decline.

FERD HAMILTON.

W 3.

IMPROVEMENT OF FOURCHE LE FEVRE RIVER, ARKANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

No operations upon this river have been carried on during the fiscal year.

The reports of my predecessor show this work to have consisted in the removal of snags, overhanging trees, bowlders, gravel reefs, and rocks in situ. There are no permanent works of construction.

The commerce to be benefited is that by rafting and small boats, hand propelled. There are no regular lines of packet or towing steamers on the river.

The Fourche Le Fevre River is considered navigable to Perryville when the Signal Service gauge at Little Rock reads not less than 6 feet. During the year (May 31, 1893, to June 1, 1894) the river was at that stage May 31 to July 28, August 13–21, September 29 to October 12, November 29 to December 5, 1893; also January 22 to May 29, 1894.

This river is the only available means for transporting crops and supplies, except by hauling in wagons to the Arkansas River and the Little Rock and Fort Smith Railway. A general report on the resources of its valley is given on p. 2127, Annual Report Chief of Engineers, 1893.

The small plant held under this head has been, by authority of the Chief of Engineers, consolidated with that held for improving Arkansas River.

The appropriations for this work have been as follows:

March 3, 1879	$10,000.00
June 14, 1880	4,000.00
March 3, 1881	3,000.00
August 2, 1882	4,000.00
August 5, 1886	5,000.00
September 19, 1890	7,500.00
	33,500.00
Received on account of sale of snag boat *Pioneer*	3,500.00
Total	37,000.00
Expended to June 30, 1893	32,508.50

Money statement.

July 1, 1893, balance unexpended	$4,491.50
June 30, 1894, amount expended during fiscal year	3,071.46
July 1, 1894, balance unexpended	1,420.04
July 1, 1894, outstanding liabilities	5.00
July 1, 1894, balance available	1,415.04

Expense account.

Pay roll	$481.46
Office rent	85.00
Telephone rent	5.00
Purchase of U. S. snag boat *Missouri*	2,500.00
Total	3,071.46

COMMERCIAL STATISTICS.

List of boats that navigated Fourche Le Fevre River, May 31, 1893, to June 1, 1894.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Ft. in.	Ft. in.			
Border City	Stern-wheel.	88.86	1 2	3 0	Mouth and Perryville...	(*)	.....
New Mary Morgan	....do	67.62	1 2	2 6	.....do.....	8	80

*Number of trips not reported.

Summary of freights reported.

Articles.	Tons.	Articles.	Tons.
Cotton	225	Provisions	750
Cotton seed	213	Grain	400
Hides and skins	2	Miscellaneous	260
Live stock	12		
Flour	21	Total	1,908
Lumber	25		

There is some rafting and flatboating on this river. No report of this was obtained by inquiry.

W 4.

IMPROVEMENT OF PETIT JEAN RIVER, ARKANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To render the stream navigable by light-draft boats during medium and high stages as far as Danville, Ark. (about 45 miles).

Project 1886 (continuing).—To remove snags, drift, and overhanging trees; 1888 (completed in 1891), to remove a portion of ledges at Slaty Crossing and Robinsons Ridge. This work was completed to Rocky Crossing in 1888, and has not till this year been carried above that point.

OPERATIONS OF THE FISCAL YEAR.

September 9 to 14: The hand-propelled snag boat *Missouri* having been brought from the St. Francis River, and finding a bar across the mouth of the Petit Jean impassable, a wing dam of brush was constructed to cause a scouring out of the bar. This was unsuccessful, and the crew was discharged.

September 15 to February 27: The custodian took advantage of a rise to cross the bar; on December 7 an engineer and two laborers were sent him, and with their aid Rocky Crossing was reached on January 2. A foreman was sent from the *Henry Sheldon* (about laying up at Dardanelle), and provisions for one month were shipped from Little Rock to Dardanelle, and hauled across to the Petit Jean. Work was begun on February 2, and carried as far as Danville by February 27, when the boat was laid up. Seventy-one snags were removed; 12 drift piles, one of which, about 8 miles below Danville, extended some 400 yards of channel distance, were cut through; 970 overhanging trees were cut. The work was delayed near its beginning by a sudden rise of about 15 feet.

March 27 to April 4: The *Missouri* was floated down the Petit Jean, taking advantage of a rise in the Arkansas, and towed to Dardanelle.

CHANNEL.

From Danville to Rocky Crossing (27 miles) a channel 30 feet wide has been cleared of all snags dangerous at such stage as to give 2 feet of water on the rocky reefs, of which there are three in this reach reported as nearly dry at low water.

From Rocky Crossing to the mouth (18 miles) there is a narrow channel navigable by steamboats at moderately high stages of the Arkansas, which back up the water of the Petit Jean. The rises of the latter river are of too short duration to be of value to navigation.

The bridge at Rocky Crossing is an absolute bar to steamboat navigation from Danville to the mouth. It has no draw, and, at a stage giving 2 feet of water on the rocky shoal above it, has a clearance of little over 22 feet.

The commerce to be benefited by clearing this river is mainly carried on by small flats floated with the current and by rafting. No complete statistics of it have been obtainable. One raft passed down during the work, as soon as the long drift pile was opened. One steamer has made one round trip to Rocky Crossing, carrying a load of 123.9 tons in all.

The small plant held under this head has been, by authority of the Chief of Engineers, consolidated with that held for improving Arkansas River.

The appropriations for this work have been as follows:

August 5, 1886	$3,500.00
August 11, 1888	2,500.00
July 13, 1892	3,500.00
Total	9,500.00
Expended to June 30, 1893	6,007.00

Money statement.

July 1, 1893, balance unexpended	$3,492.50
June 30, 1894, amount expended during fiscal year	3,306.84
July 1, 1894, balance unexpended	185.66
July 1, 1894, outstanding liabilities	8.00
July 1, 1894, balance available	177.66

Expense account.

Pay roll	$2,641.09	Medicine	$0.75
General supplies	123.95	Telegrams	2.17
Subsistence	283.01	Reserved in U. S. Treasury for freight charges	4.14
Transportation	17.03		
Fuel	209.65	Total	3,306.84
Traveling expenses	25.05		

COMMERCIAL STATISTICS.

The river was reported navigable during June, 1893, part of February, March, April, and May, 1894.

The steamer *New Mary Morgan* (67.62 tons) is the only steamboat reported as having been in the river during the last year. She made one trip to Rocky Crossing.

Tonnage reported June 1, 1893, to May 31, 1894.

Articles.	Tons.
Cotton	53.25
Hides and skins	.40
Provisions	60
Miscellaneous freights	10
Eggs	.25
Total	123.90

There is some rafting carried on during the spring, the amount of which was not reported.

W 5.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To secure and maintain a navigable channel of not less than 2 feet in depth at low water above Newport, and not less than 5 feet in depth at low water from Newport to the mouth.

Project.—To remove snags and overhanging trees; to blast and dredge bowlders and rock or gravel reefs; to contract the channel where necessary by dams and spur dikes.

PRESENT WORKS.

ABOVE NEWPORT.

Summers Shoals.—On right bank, 147.6 miles above Newport, one stone and brush wing dam; built 450 feet long in fiscal year 1882; repaired fiscal year 1884. Present condition: 75 feet washed out of center, leaving 375 feet intact; average height, 1 foot above low water.

Crooked Creek Shoal.—On left bank, 139 to 140 miles above Newport, four stone wing dams 775, 675, 160, and 185 feet, total 1,795 feet; built in fiscal year 1882. Present condition: The 775-foot dam almost gone; barely shows at low water. The 675-foot dam gone, with the exception of the training wall. This is 250 feet long; 2.5 feet above low water. The two remaining barely show at a stage of 0.5 foot.

Buffalo Shoals.—133 to 134 miles above Newport, on right bank four stone wing dams 300, 200, 300, and 175 feet, total 975 feet. On left bank two stone wing dams, 100 and 150 feet, total 250 feet; built fiscal years 1879-'80, repaired fiscal years 1886, 1890, 1894. Present condition: Original lengths are retained, and the dams are 3.5 feet above low water.

The Rapides.—On right bank, 115 miles above Newport, two stone dams 225 and 50 feet; built in fiscal year 1880, 240 and 500 feet. Present condition: The 225-foot dam is 1 foot above low water, excepting in two places, 20 and 30 feet, where it is 0.5 foot below low water. The 50-foot dam is 2 feet above low water.

Samms Island.—On left bank, 101½ miles above Newport, one stone, gravel and brush dam 125 feet long; built in fiscal year 1887. Present condition: Just shows at low water.

Samms Shoal.—On left bank, 100 miles above Newport, one stone, gravel, and brush dam 250 feet long; built fiscal year 1881, rebuilt fiscal year 1887. Present condition: Average height, 0.5 foot above low water.

Piney Creek.—On right bank, 95.8 miles above Newport, one stone dam 150 feet; built in fiscal year 1887, 418 feet. Present condition: Average height, 1 foot above low water.

Widemans Shoal.—On left bank, 94½ miles above Newport, one stone dam 120 feet, two stone, gravel, and brush dams 120 and 60 feet, total 300 feet; built in fiscal year 1887. Present condition: The stone dam is 3 feet above low water, the 120-foot stone, gravel, and brush dam washed flat to low water, the 60-foot stone, gravel, and brush dam is 2.5 feet above low water.

Fishtrap Shoals.—On left bank, 94 miles above Newport, one stone dam 388 feet; built in fiscal year 1887. Present condition: Average height, 0.5 foot above low water.

Bone Island.—On left bank, 92.3 miles above Newport, one stone dam 68 feet; built in fiscal year 1887. Present condition: Average height, 1 foot above low water.

Perrins Shoals.—On left bank, 87 miles above Newport, one stone wing-dam 192 feet long; built in fiscal year 1886, repaired in fiscal year 1887. Present condition: Average height, 1 foot above low water.

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vay, the remaining por-

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dition: The 462-foot dam
height of remaining por-
t dam is intact; average

iles above Newport, one
fiscal year 1886, repaired
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r.

e dike 145 feet long, built in

es below Newport, two stone
water, 125 feet each; built

Near St. Charles.—On right bank, 192 miles below Newport, two stone and brush dikes, built to a height of 4 feet above low water, 100 feet each; built in fiscal year 1894.

Head of Little Island.—On left bank, 219½ miles below Newport, two stone and brush dikes, 100 feet each, built to a height of 4 feet above low water; built in fiscal year 1894.

OPERATIONS OF THE FISCAL YEAR.

July 1 to 8: Quarrying at Bee Rock closed and floating plant prepared for removal. July 29 to August 26: Dikes Y and Z at Little Island constructed, each 100 feet long. Brush cut in the vicinity was made into fascines 15 to 18 inches in diameter, 20 feet long; these were bound together by wires into a continuous mattress 20 feet wide for the base. Leaving of this mattress an apron 10 feet wide to catch overfall, the dike was built up by alternate layers of stone and brush to low water, then of stone only to 4 feet stage, with crown 3 feet wide; upstream slope, 1 on 2; outer end slope, 1 on 4; downstream slope, natural.

September 21 to October 6: Dikes W and X, near St. Charles, similar to above, constructed.

October 23 to November 18: Dikes U and V, near Aberdeen, similar to above, but 125 feet long, constructed.

Statement of material used in dikes in the vicinity of Little Island.

[Work begun July 29, completed August 26, 1893. Length of dikes, 100 feet, built to 4-foot stage. Width of crown, 3 feet.]

Nature of material.	Dike Y.	Dike Z.	Total.
Mattress.....square feet..	4,820	4,740	9,560
Stone.....cubic yards..	365	450	815
Wire.....pounds..	760	740	1,500
Brush.....cords..	110	104	214

Statement of material used in dikes in vicinity of St. Charles.

[Work begun September 21, completed October 6, 1893. Length of each dike, 100 feet, built to 4-foot stage. Width of crown, 3 feet.]

Nature of material.	Dike W.	Dike X.	Total.
Mattress.....square feet..	3,140	3,000	6,140
Stone.....cubic yards..	256	247	503
Wire.....pounds..	410	350	760
Brush.....cords..	66	72	138

Statement of material used in dikes in vicinity of Aberdeen.

[Work begun October 23, 1893, completed November 18, 1893. Length of each dike, 125 feet, built to 4-foot stage. Crown 3 feet wide.]

Nature of material.	Dike U.	Dike V.	Total.
Mattress.....square feet..	5,340	7,920	13,260
Stone.....cubic yards..	345	570	915
Wire.....pounds..	644	1,012	1,656
Brush.....cords..	68½	97½	166

The stone was towed to the dikes by the U. S. towboat *C. B. Reese* until August 26; after September 16 the work was done by the U. S. snag boat *Wichita*. The laborers on the work at the dikes were quartered on the U. S. quarter boat *Albany;* those at the Rock Pile were quartered on a store barge that was fitted up temporarily with bunks and cooking outfit. It was intended to erect one or more dikes just below Mount Adams, but there was not a sufficient quantity of stone left after the completion of the other dikes. The remaining stone was loaded on barges, and the entire plant, excepting the *Wichita*, towed to Clarendon and laid up. This boat was dispatched to the upper river, arriving at Batesville on December 4. On the way up the *Wichita* towed the U. S. snag boat *Riverside* (hand propelled) from De Valls Bluff to the mouth of Black River.

December 4 to February 3: Operating by snag boat *Wichita* between Batesville and the reach above Buffalo Shoals; 128 snags were removed and 354 trees cut. Also 40 bowlders removed from Nellies Apron Shoals, 8 bowlders and 12 cubic yards of rock reef from Hayes Ferry Shoals; 252 bowlders and 44 cubic yards rock reef removed from Buffalo Shoals and 296 cubic yards stone used in repairing wing dams on Buffalo Shoals. The stage of water was very favorable for removing low-water obstructions. The steamer lay at the foot of Buffalo Shoals from January 17 until January 27, waiting for sufficient water to pass over. Over the following shoals the boat had to be lined: Maxwells Gin, Dark Corner, Mosley, Cackling Pullet, Wolf Bayou, Shipps and Nellies Apron; also through Boone Chute.

For the work on Buffalo Shoals a raft was constructed of timber cut at the head of the shoals, the necessary tools for blasting and handling rock being carried on this, and the work carried from the head of the shoals downstream. The steamer returned to Batesville on the 31st of January, did three days' work in the harbor, and was placed in the care of a custodian.

No stone was taken from Bee Rock Quarry during this year; the property at this point was cared for by a custodian.

Surveys were made in the vicinity of St. Charles, Aberdeen, and Mount Adams by the party that constructed the dikes in this portion of the river. A survey was also made of the river in the vicinity of Batesville, to show the locality of the Government works at this point and the effects produced by the same; this was made the subject of a special report by my predecessor.

PLANT.

A new hull was built at Little Rock, Ark., for the U. S. snag boat *Henry Sheldon*. This work was begun August 4, 1893, the hull launched October 4, 1893, the upper works and machinery transferred from the old to the new hull, and the boat ready for the field November 17, 1893. The plant held under this head has been increased by the consolidation with it of that held for tributaries of the White River.

CHANNEL.

May 27 to June 1: I saw the river below the Little Red from the steamer *Emma Ethridge*, under charge of Capt. C. McD. Townsend, Corps of Engineers. The steamer, 165 feet long, carried a tow of six barges loaded to 5 feet; steamer and tow had a length of 425 feet, and breadth *of 86 feet. The lower river* was at bank-full stage. With lit-

tle trouble from snags at this stage, the need of much cutting of overhanging timber was evident to enable a tow of this size to "flank" the narrow points. That any snags were seen at this stage shows need also of snagging operations for low-water navigation.

The obstructions at Buffalo Shoals are well shown by the experience of the *Wichita*, drawing 22 inches, at extreme low water. At Maxwell's Gin and at Mosely she touched; at the other places noted the use of lines was necessary, from insufficient room or from swift current.

On the upper river twenty different shoals are reported between Batesville and McBees Landing, a distance of 102.5 miles. They are generally of rock, reef, gravel, or bowlders.

The banks of this river are generally stable, so steep in the lower reaches that high and low water widths differ very little. The water carries little sand or silt; bar-building is very slow, and the bars are hard.

The railroad bridge at De Valls Bluff (crossing of the Memphis and Little Rock Railway) is difficult of passage by large tows; guide piling for the channel pier would probably remedy this.

The piers of a proposed bridge at Aberdeen (upper works never built) are also an obstruction at certain stages; at bank-full stage it is possible to pass over them; at extreme low stage they are out of water; at intermediate stage they make a somewhat dangerous passage.

COMMERCE AND TONNAGE.

The traffic on White River is in two distinct sections, from Des Arc to Indian Bay, a reach of about 94 miles, and from Newport to Sugar Loaf, a reach of about 205 miles. This appears to be determined solely by business relations; the river is equally navigable, below and between these sections.

This commerce is carried on by light-draft boats, which can run all the year, and which carry one or more barges when freights require it. These full loaded, with barges, are from 50 to 250 tons.

An important addition to the tonnage of the river is 50,700 cubic yards of riprap stone and spawls, towed by the United States from a few miles above Judsonia, on the Little Red River, via the White River, to the Mississippi, for works under the Mississippi River Commission. Steamers have taken tows usually of six large barges, loaded to 5 feet, until the last tow. This work was carried on from February 13 to June 5. It, rather than the actual commerce, shows the capacity of the river.

From Batesville to Jacksonport the White River is paralleled on the left bank by the Diaz and Batesville branch of the St. Louis, Iron Mountain and Southern Railway; from Jacksonport to Newport it is paralleled by White and Black River Valley Railway, also on the left bank. Three miles below Newport it is crossed by the main line of the St. Louis, Iron Mountain and Southern Railway. This railroad lies within 12 miles of the river (on the right bank) to Augusta. On the left bank, between Newport and Augusta, the White and Black River Valley Railway lies within an average distance of 9 miles. Near De Valls Bluff the river is crossed by the Little Rock and Memphis Railroad, and at Clarendon by the St. Louis Southwestern Railway.

APPROPRIATIONS AND EXPENDITURES.

Appropriations for this river have been partly for limited reaches, partly for the whole river, and partly for this river in combination with others. Of the distribution of the expenditures under the latter *appropriations*, I am unable to render any information.

he appropriations for this river separately, and for reaches of it, as follows:

3 23, 1874	$50,000.00	July 5, 1884	$35,000.00
. 14, 1876	10,000.00	Aug. 5, 1886	18,000.00
ch 3, 1879	10,000.00	Aug. 11, 1888	25,000.00
e 14, 1880	20,000.00	Sept. 19, 1890	30,000.00
e 14, 1880	5,000.00	July 13, 1892	75,000.00
ch 3, 1881	8,000.00		
. 2, 1882	6,000.00	Total	296,000.00
. 2, 1882	4,000.00	Expended to June 30, 1893	247,198.49

Money statement.

r 1, 1893, balance unexpended	$48,801.51
e 30, 1894, amount expended during fiscal year	40,756.65
y 1, 1894, balance unexpended	8,044.86
y 1, 1894, outstanding liabilities	501.69
y 1, 1894, balance available	7,543.17
mount (estimated) required for completion of existing project	78,815.00
mount that can be profitably expended in fiscal year ending June 30, 1896	30,000.00

ubmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Expense account.

y roll	$22,616.39	Telegrams	$40.60
neral supplies	2,725.01	Skiffs	50.00
bsistence	4,358.45	Telephone rent	20.00
el	1,813.47	Water rent	17.00
nsportation	247.01	Purchase of the U. S. quarter boats *Yorktown* and *Greenwich*	5,000.00
mber	2,972.02	Reserved in U. S. Treasury for freight charges	111.68
dicine	90.81		
leage	32.80	Total	40,756.65
ck	63.26		
ice rent	340.00		
veling expenses	169.95		
tionery	88.20		

COMMERCIAL STATISTICS.

alico Rock was reported as the head of navigation until last of January, 1894. m February 4 to May 10 navigation was good to McBees Landing. No report of igation above Noes Ferry was received.

List of boats engaged in navigating White River June 1, 1893, to May 31, 1894.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Ft. In.	Ft. In.			
h	Stern-wheel.	113.16	1 8	4 0	No report		
F. Carter	do				do		
Bragg	do	164	1 6	3 6	Newport and Mouth of Black	102	1,432
	do	141	1 5	3 6	Des Arc and Devalls Bluff	149	1,404
					Batesville and Noes Ferry	1	
					Batesville and McBees Landing	8	
Woodson	do	219.78	1 6	3 0	Batesville and Buffalo City	6	338
					Batesville and Mount Olive	2	
					Batesville and Padget Island	1	
all	do	49	1 10	3 0	Batesville and Buffalo City	5	115
le	do				No report		
and	do				do		

The steamer *Myrtle* was built last fall at McBees Landing for the Upper White River trade.

This spring Morrison & Decker, at Newport, have built a stern-wheel boat for the trade between Newport and Des Arc. The boat is 135 feet long, 32½ feet beam, and 4 feet depth of hold. Draft, light, is 20 inches.

Summary of commerce reported June 1, 1893, to May 31, 1894.

Articles.	Tons.	Articles.	Tons.
Cotton	2,931	Grain	332
Cotton seed	1,936	Miscellaneous freights	1,930
Hides and skins	10	Railroad ties (rafted)	5,940
Live stock	523	Saw logs (rafted)	21,644
Lumber	5,381		
Staves	2,722	Total	43,635
Provisions	286		

W 6.

IMPROVEMENT OF CACHE RIVER, ARKANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To improve navigation from the mouth to Riverside, Ark. (100 miles), at low stages of the river, by removal of obstructions, which consist of snags, logs, overhanging trees, and shoals.

Project.—To remove obstructions by operation of light-draft snag boats, the shoals being believed to be formed on logs and snags.

In the fiscal year 1893 this work had been carried as far as James Ferry. On June 30, 1893, a severe storm sweeping across the river between James Ferry and Kalachi blocked it with fallen timber.

OPERATIONS OF THE FISCAL YEAR.

July 10 to August 5: The hand-propelled snagboat *Riverside* (laid ud at James Ferry) resumed operations and worked up to White and Black River Valley Railway bridge (18¾ miles) and back again. One hundred and twenty-eight snags were removed; 425 trees cut.

The boat was then towed to Black River.

No steamers ply on this river. Its commerce consists of rafting and small flatboats handled by the current. No accurate information of this commerce, separate from that of the White River, which it joins at Clarendon, have been obtained.

The small plant held under this head has, by authority of the Chief of Engineers, been consolidated with that held for improving White River.

The appropriations for this work are as follows:

August 11, 1888	$7,000.00
July 13, 1892	2,000.00
	9,000.00
Received on account of sale of snag boat *Riverside*	2,000.00
Total	11,000.00
Expended to June 30, 1893	9,825.58

Money statement.

July 1, 1893, balance unexpended	$1,174.42
June 30, 1894, amount expended during fiscal year	1,062.41
July 1, 1894, balance unexpended	112.01
July 1, 1894, outstanding liabilities	4.00
July 1, 1894, balance available	108.01
Amount (estimated) required for completion of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Expense account.

Pay roll	$875.66	Traveling expenses	$21.85
General supplies	44.41	Deposited to credit of U. S. Treasury for freight charges	12.67
Medicine	3.75		
Telegrams	1.72		
Subsistence	99.10	Total	1,062.41
Transportation	3.25		

W 7.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To improve navigation by removing obstructions consisting of snags, overhanging timber, and shoals.

Project.—Snagging operations, and, in the earlier years, the closing of chutes by dams.

OPERATIONS OF THE FISCAL YEAR.

Work was not begun on this river until the 1st of December, 1893, on account of the snag boat belonging to this appropriation being at work on the Cache River, and not returned until late in November, 1893. The *Riverside* entered Black River December 1, and worked up to the mouth of Current River (about 149 miles), arriving there December 22. No obstructions were met with between the mouth of the river and Lochardt's Landing (about 80 miles up the river). At this point the boat worked one week, removing 39 snags. The next serious obstruction was found at Clover Bend (about 12 miles above Lochardt's); here 30 snags were removed. During the season there were 181 snags removed and 6 trees cut. At the close of the work the boat returned to Black Rock and was placed in the care of a custodian.

PLANT.

The plant held under this appropriation has been, by authority of the Chief of Engineers, consolidated with that held for improving White River.

CHANNEL.

This river, which I have not been able to visit, is reported as having the character of the Lower White River. Its banks are stable, and the principal obstructions are those removable by snagging operations.

The Black River is crossed at Poplar Bluff, Mo., by the Poplar Bluff and Cairo Branch of the St. Louis, Iron Mountain and Southern Railway; near Corning Ark., by the main line of the St. Louis, Iron Mountain and Southern Railway; at Black Rock by the main line Kansas City, Fort Scott and Memphis Railway, and near Paroquette Bluff by the Diaz and Batesville Branch of the St. Louis, Iron Mountain and Southern Railway. From Poplar Bluff, Mo., to the mouth the river is paralleled by the main line of the St. Louis, Iron Mountain and Southern Railway. The greatest distance apart is about 12 miles.

COMMERCE AND TONNAGE.

Commerce on this river is carried on by small light-draft steamers which can run all the year, carrying barges when the amount of freight requires them. They ply on this stream only, or down the White as far as Newport.

This commerce is in two sections—one from Newport to the mouth of Current River, 7 miles on the White and 149 on the Black, and one from Corning Mills to Poplar Bluff, about 95 miles. The division is determined by the business; the river is equally navigable in the intervening reach of about 100 miles.

APPROPRIATIONS AND EXPENDITURES.

Appropriations have been made for this river separately and in combination with other rivers. Of the distribution of the expenditures under the latter appropriations I have no information to present.

The appropriations for this river, separately, are as follows:

June 14, 1880	$15,000.00	September 19, 1890	$5,000.00
March 3, 1881	6,000.00	July 13, 1892	5,000.00
August 2, 1882	10,000.00	Sale of snag boat *Sheldon*	4,500.00
July 5, 1884	20,000.00		
August 5, 1886	5,000.00	Total	75,500.00
August 11, 1888	5,000.00	Expended to June 30, 1893	71,897.32

Money statement.

July 1, 1893, balance unexpended	$3,602.68
June 30, 1894, amount expended during fiscal year	2,498.27
July 1, 1894, balance unexpended	1,104.41
July 1, 1894, outstanding liabilities	52.00
July 1, 1894, balance available	1,052.41
Amount (estimated) required for completion of existing project annually	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Expense account.

Pay roll	$2,097.51	Telegrams	$5.62
General supplies	73.45	Office rent	85.00
Subsistence	181.32	Reserved in U. S. Treasury for freight charges	.25
Transportation	23.57		
Stationery	8.35		
Traveling expenses	22.30	Total	2,498.27
Medicine	.90		

COMMERCIAL STATISTICS.

The river was reported navigable to Poplar Bluff, Mo., all the year. Above the month of Current River rafting season begins in December and ends in June. Below the mouth of Current River rafting may be carried on all the year.

List of boats engaged in navigating Black River, Arkansas and Missouri, June 1, 1893, to May 31, 1894.

Name.	Class.	Tonnage.	Draft. Light.		Draft. Loaded.		Between—	Round trips.	Passengers.
			Ft.	in.	Ft.	in.			
Ada*	Screw.	4	2	11	3	9	Poplar Bluff and Gillis Bluff..	(†)	.....
Moark*	Stern-wheel.	27.33	1	4	2	0	Limits of trips not reported...	100	None.
Rambler*	...do ..	11	1	2	3	6	.....do.....	(‡)	.....
A. R. Bragg	...do ..	164	1	6	3	6	Mouth and Pocahontas.....	102	1,432
Portia	...do ..	49.60	1	6	3	0	{Black Rock and Pocahontas...	104}	576
							{Black Rock and Dyers Mill ...	104}	
Tom Young	...do ..	.....	.....		.....		No report	.....	.....

* With barges.
† Two trips per week, average 10 passengers per trip.
‡ Number of trips not reported.

The steamer *Rambler* entered this river about the first of the year 1894. The steamer *Tom Young* left this river in May, 1894.

Summary of commerce reported June 1, 1893, to May 31, 1894.

Articles.	Tons.	Articles.	Tons.
Cotton	2,545	Grain	372
Cotton seed	1,524	Miscellaneous freights	1,808
Hides and skins	10	Spokes	1,780
Live stock	59	Railroad ties (rafted)	12,375
Lumber	9,710	Saw logs (rafted)	39,300
Staves and boats	17,412		
Provisions	632	Total	87,536

W 8.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant General's Office, series of 1893.

Object.—To improve navigation by removal of obstructions, consisting of snags, overhanging timber, etc.

Project.—The usual snagging operations.

OPERATIONS OF THE FISCAL YEAR.

The U. S. snag boat *A. B. Johnson* (hand propelled), after repairs began snagging operations at Madison, Ark., on October 29, 1893, and concluded them January 20, 1894. The work was confined to the reach of river between Madison, Ark., and Marked Tree, Ark. (a distance of about 122 miles), the boat going over this reach twice. Seven hundred and seventy snags were removed, 5,298 trees cut and 1 drift pile destroyed. At the close of the work the boat was laid up at Madison, Ark. The stage of water was favorable for removing low-water obstruc-

tions; the boat had to pull over a bar about 8 miles below Wittsburg, and in pulling over Wittsburg Bar broke the capstan. This caused a delay of three days, until a new capstan could be sent from Little Rock. The foreman in charge of the boat reports the river to be good most of the way. Snags are large trees, that have fallen into the river and lie along the shore. Overhanging trees are numerous.

PLANT.

Snag boat *A. B. Johnson*, lying at Madison, was repaired by complete renewal of forward deck and top gunwales forward.

The plant held under this head has, by authority of the Chief of Engineers, been consolidated with that held under improving St. Francis River, Missouri, in one return.

CHANNEL.

The basin of this river is low and subject to overflow from the Mississippi River. Its floods and its navigable stages depend upon those of that river.

The governing bar is reported to be the Ford, about 25 miles above the mouth. At a Mississippi River stage of 9 feet on Memphis gauge a draft of 5 feet can be taken over this bar and all above it.

COMMERCE AND TONNAGE.

The principal traffic on this river in Arkansas is by the Lee Line of steamers, drawing 30 inches light and loading to 5 feet, plying from Memphis to the Cut-off, about 36 miles from the mouth. There is also rafting, and some work by small steamers of less than 50 tons running nearly all the year. Little information in regard to this traffic has been received in answer to repeated inquiry.

APPROPRIATIONS AND EXPENDITURES.

Appropriations have been made for this river, both separately and in combination with other rivers, since 1871. Of the distribution of the combined appropriations, which were not under this office, I am unable to render any information.

The separate appropriations are as follows:

March 3, 1871	$10,000.00
June 14, 1880	5,000.00
July 5, 1884	12,000.00
August 5, 1886	8,000.00
August 11, 1888	4,000.00
September 19, 1890	4,000.00
	43,000.00
Expended to June 30, 1893	38,752.47

Money statement.

., 1893, balance unexpended	$4,247.53	
ved on account deposit made by Capt. H. S. Taber	.16	
		$4,247.69
30, 1894, amount expended during fiscal year		3,795.12
1, 1894, balance unexpended		452.57
1, 1894, outstanding liabilities		50.00
1, 1894, balance available		402.57
nount (estimated) required for completion of existing project annually		8,000.00
nount that can be profitably expended in fiscal year ending June 30, 1896		8,000.00
ıbmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Expense account.

r roll	$2,833.21	Purchase of property on appropriation for improving L'Anguille River, Arkansas.	$25.00
ıeral supplies	136.28		
ɔistence	523.98	Purchase of property on appropriation for improving Saline River, Arkansas	22.00
ınsportation	43.93		
el	5.67	Reserved in U. S. Treasury for freight charges	27.99
mber	85.38		
ıveling expenses	71.00	Total	3,795.12
ıtionery	12.51		
legrams	8.17		

COMMERCIAL STATISTICS.

Marked Tree was reported as the head of low-water navigation from June to tober.

List of steamboats that navigated St. Francis River June 1, 1893, to May 31, 1894.

Name.	Class.	Tonnage.	Draft. Light.	Draft. Loaded.	Between—	Round trips.
			Ft. in.	*Ft. in.*		
lta	Stern-wheel.	45	1 5	2 6	Lesters and Bowlins Ferry	72
ary Avy	Stern-wheel.	40	1 1	1 8	(*)	(*)
a Lee	Stern-wheel.				Mouth and Cut-off	(†)

* Limits and number of trips not reported. † No report received.

Summary of commerce reported.

Articles.	Tons.	Articles.	Tons.
tton	125	Staves	5,860
tton seed	60	Grain	43
des	2	Saw logs (by rafts)	12,000
re stock	45	Miscellaneous freights	1
mber (by steamboats)	575		
mber (by rafts)	1,000	Total	19,763
ovisions	52		

EXAMINATION AT WALNUT BEND, ARK., TO DETERMINE THE PROBABILITY OF THE MISSISSIPPI RIVER CUTTING THROUGH INTO THE ST. FRANCIS RIVER AT THAT POINT.

[Printed in Senate Ex. Doc. No. 104, Fifty-third Congress, second session.]

WAR DEPARTMENT,
Washington, D. C., May 29, 1894.

SIR: In response to the joint resolution of Congress approved May 4, 1894, I have the honor to transmit herewith a letter of the Chief of Engineers, dated May 29, 1894, submitting a copy of a report of Lieut. Col. Charles R. Suter, Corps of Engineers, on "an examination at Walnut Bend, Ark., to determine the probability of the Mississippi River cutting through the St. Francis River at that point."

Very respectfully,

JOSEPH B. DOE,
Acting Secretary of War.

The PRESIDENT OF THE UNITED STATES SENATE.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., May 29, 1894.

SIR: I have the honor to submit the accompanying copy of a report, dated the 26th instant, from Lieut. Col. Charles R. Suter, Corps of Engineers, on an examination at Walnut Bend, Ark., to determine the probability of the Mississippi River cutting through into the St. Francis River at that point.

This report is made in response to a joint resolution of Congress approved May 4, 1894, as follows:

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to cause an examination to be made to determine if there is probability and danger of the Mississippi River cutting through the space dividing such river from the Saint Francis River in the vicinity of Walnut Bend, Arkansas, some twenty miles above the mouth of the Saint Francis River, and if such danger exists, to cause to be made a survey and estimate of the amount necessary to prevent damage to the navigation of the Saint Francis River.

Col. Suter thinks that the danger of the formation of a cut by the action of overflow water from the Mississippi into the St. Francis is imminent. He considers that the only means of averting this danger lies in constructing a levee long enough to turn the overflow water from this dangerous neighborhood. It is estimated that the cost of such a levee would be $112,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. CHAS. R. SUTER, CORPS OF ENGINEERS.

MISSOURI RIVER COMMISSION,
OFFICE OF THE PRESIDENT,
St. Louis, Mo., May 26, 1894.

GENERAL: In accordance with your instructions of April 25, 1894, I visited Walnut Bend, Ark., on May 2, to examine into the probability of the Mississippi cutting through into the St. Francis River at that point. Through the courtesy of Capt. S. W. Roessler, Corps of Engineers, U. S. Army, I was enabled to visit the locality on one of the Government towboats in company with himself and two members of the St. Francis Levee Board. I was thus enabled to run up the St. Francis River to the point of threatened cut-off and to secure quite full information on the ground. After my return to St. Louis I received your further instructions of May 1, and subsequently, under date of May 9, I was directed to report on Public Resolution No. 21, approved May 4, 1894, which is as follows:

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to cause an examination to be made to determine if there is probability and danger of the Mississippi River cutting through the space dividing such river from the Saint Francis River in the vicinity of Walnut Bend, Arkansas, some twenty miles above the mouth of the Saint Francis River, and if such danger exists, to cause to be made a survey and estimate of the amount necessary to prevent damage to the navigation of the Saint Francis River.

The accompanying map* shows the detailed topography at this locality, while the small map* attached shows the relative position of the Mississippi and St. Francis rivers for a considerable distance above and below. The situation is as follows: Due west from Walnut Bend of the Mississippi the St. Francis, bending to the east, approaches to within 1½ miles of the Mississippi. It then flows in a generally westerly direction till it reaches Crowleys Ridge, at the mouth of L'Anguille River, and then follows this ridge to its junction with the Mississippi River at Sterling. The general shape and position of Walnut Bend had remained sensibly unaltered till about 1870, when a chute behind one of the islands on the point opposite began to enlarge, and after a few years became the main channel of the river. This change of channel into Bordeaux Chute had the same general effect as a cut-off, and the old bend is rapidly silting up and becoming a lake. Considerable caving took place after this change, and is still going on, the effort of the river being apparently to develop a new bend in the main right-hand bank. From 1883 to 1892 the caving is indicated on the accompanying map,* and amounts at its maximum to about 3,000 feet. It is still going on, but the point of maximum action is moving downstream toward Walnut Bend Landing and away from the St. Francis.

There is not, I think, any danger, under present conditions, of the Mississippi cutting directly through into the St. Francis. The danger comes from another quarter. In the present unleveed condition of the St. Francis Basin this whole country is submerged during overflows of the Mississippi, the immediate banks in Walnut Bend being from 9 to 12 feet under water. During the early stages of the overflow the water runs back to the St. Francis, first, through the low swales or draws, and finally over the whole country, with great force and velocity. The distance by the Mississippi from Whitehall Landing to the

* Omitted; printed in Senate Ex. Doc. No. 104, Fifty-third Congress, second session.

mouth of the St. Francis is 19 miles, and by the St. Francis fr bend back of Whitehall to the mouth is 21 miles. The Miss slope in this distance is about 10 feet at low water, 8 feet at a ba stage, and less during overflow, as the return flow from the St. F basin gives an abnormal elevation at its point of discharge. T charge proper of the St. Francis is habitually small and depe rains in the basin and its immediate vicinity. Its slope at the t my examination was but little over one-tenth of a foot to the the Mississippi being about half bank full. Its level at the low therefore depends very largely on backwater from the Missi except when heavy rains are running off or when overflow reaches its channel from the Mississippi at points below New M At such times it may be higher than the trunk stream and dis into it over the intervening bank. It is therefore apparent that Mississippi rises rapidly and goes over its banks while the St. Fra still low there will be a heavy volume of water pouring over its until either the backwater from below or overflow water from raises its surface sufficiently to check this action.

The banks of the St. Francis are relatively high. At the n neck they are as high as those of the Mississippi, but the interm ground is lower and cut up by swales or draws, separated by low r which determine the first direction of the overflow. The most imp of these, called Wheel Ridge, lies back of Walnut Bend La About half a mile north of this lies Johns Ridge, and still farther and stretching back from Whitehall Landing, is Askew Ridge water which goes out between Wheel and Johns ridges finally g into Sandy Bayou, which enters the St. Francis about 1¾ miles the narrow neck. Between Johns and Askew ridges the water through a shallow lake (Kincaid) and out through Kincaid Bayou, enters the St. Francis close by the seat of the present trouble whole country between the two rivers shows marks of erosion, a intervening woods are full of drift, carried in from the Mississippi condition of affairs consequent on a high Mississippi and low St. F seems to be an unusual one. Indeed, it must be so, or the neck have been cut through long ago. It did occur in 1893, in the latt of February, as stated by persons living in the vicinity, and as t cial gauge records show. During a period variously estimated week to ten days a gully was washed out in the bank of the St. cis and rapidly extended backward toward the Mississippi. It at a length of 1,000 feet, a width of about 200 feet, and a depth mouth of 24 feet and of 14 feet at the inner end.

The banks show the soil to be sand overlaid with clay. At th end this clay layer is about 6 feet thick, becoming thinner towa river. As the water pours over the edges of this gully the sand v out, letting down the upper stratum of clay, and so the cut ad into the land. The rapid formation of this gully has naturally g alarmed all the people along the Lower St. Francis. In fact, th ger seems very imminent. Although the condition of affairs i may not recur for some years, this is by no means certain, and, b it is probable that this cut, being now fairly formed, may go on e ing under conditions which would not have rendered its origi mation possible. Moreover, the levees now being built along th of the basin will cut off more or less of the overflow, and thus the dangerous period, and this period will also tend to become every year as levee construction advances. Although, without doubt, the numberless bayous leading from the Mississippi ba

the swamp basins have mostly been formed in this way, yet they occur generally in woods, where they become more or less choked with fallen trees or drift and ultimately lined with a clay deposit which prevents further enlargement. In the present case the cut is in an open field, and has only a narrow belt of woods to pass through before again reaching open ground extending to the Mississippi. The exceedingly short distance to be traversed forms the greatest danger, however, and I think that there is every reason to anticipate that unless something is done very soon a communication will be opened up with the St. Francis at this point. This conceded, it remains to be seen what the probable consequences would be.

The fear entertained by some persons that the Mississippi would be diverted into the St. Francis may, I think, be dismissed without much discussion. As already stated, the distance to the mouth of the St. Francis is about the same by both rivers, and as the Mississippi channel is already formed, while that of the St. Francis is insignificant in comparison, there would seem to be no inducement for such a change. There have been a great many similar cases along the river, the result usually being that the smaller stream is cut off from its old channel and brought into the Mississippi through the new mouth formed. This, I think, would ultimately occur here. There would, for a time, be a considerable flow of Mississippi water in the lower branch, which would probably rapidly silt up and become choked with drift, as was once the case with the Atchafalaya and other large bayous. In any case I think it could safely be predicted that the navigation of the Lower St. Francis would be very seriously injured if not destroyed. The most serious result would probably be to the water level. As this would now be taken from the Mississippi at Walnut Bend, instead of at Sterling, 19 miles below, the intermediate fall would be lost and the St. Francis would be raised 8 or 9 feet. This would submerge a very large territory and ruin much valuable farming land. At present the banks of the St. Francis, in its lower course, are quite high, and are occupied by valuable plantations. Many of these have been abandoned of late years owing to the frequency and long duration of recent floods, but the effort now being made to levee the basin will soon render their reoccupation profitable. A disaster such as now seems impending would render these levees of small value so far as concerns the lower part of the St. Francis Basin.

As the whole danger lies in the overflow, the most obvious, and, in fact, the only means of averting it, lies in constructing a levee long enough to turn the overflow water from this dangerous neighborhood. Such a levee would ultimately form part of the continuous front line, and in the interest of economy should be so constructed with regard to grade and dimensions as to render it available for this purpose. Capt. H. N. Pharr, chief engineer of the St. Francis Levee Board, has furnished me with a map showing the location and profile of such a levee as would probably be suitable. The line is about 6 miles long, and extends from Wheel Ridge to the head of old Walnut Bend. With 8 feet crown, and side slopes of 1 on 3, the estimated yardage is about 44,000 cubic yards, and the cost, at 15 cents per cubic yard, would be $112,000.

My conclusions may be summarized as follows:

First. The formation of a cut from the Mississippi through to the St. Francis by the action of overflow water from the Mississippi is considered as imminent.

Second. The existence of such a cut would seriously injure, if not

destroy, the navigation of the St. Francis below the cut, as also that of L'Anguille River, which enters the St. Francis 8½ miles lower down. It would also raise the level of the St. Francis and submerge much valuable land.

Third. The cost of rectification *after* the formation of this cut would be much greater, and the work would be more difficult than for preventive measures taken beforehand.

Fourth. A levee, such as herein described, would probably give absolute security as long as the present river regimen continues.

Accompanying this report is a map prepared at the office of the Mississippi River Commission which shows the topographical features of the locality. On it are also shown the position of the washout formed in 1893, the location of a portion of the proposed levee, and a profile of the neck furnished me by Capt. Pharr. A small section of the Mississippi River Commission's alluvial valley map is placed on the same sheet to exhibit the general features of the neighboring country.

Copies of a map prepared by Capt. Pharr, showing the location of the proposed levee and a profile of the same, are also appended.*

Very respectfully, your obedient servant,

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

W 9.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

This work was under charge of the late Capt. H. S. Taber, Corps of Engineers, until December 19, 1893, when I relieved him under Special Orders No. 288, Adjutant-General's Office, series of 1893.

Object.—To improve navigation by removal of obstructions, consisting of snags, overhanging timber, etc.

Project.—The usual snagging operations between Kennett, Mo. (at the head of the "sunk lands"), and Greenville, Mo.

OPERATIONS OF THE FISCAL YEAR.

No operations in the field have been carried on during the year, because of lack of funds, the greater part ($2,000) of the unexpended balance being held to meet the claims of the Dunklin County Transportation Company, if presented.

This claim has not been presented; the reserve is still so held.

CHANNEL.

Work has been carried, in previous years, up to 12 miles below Greenville. Need of further operations is reported.

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*Not submitted.

COMMERCE AND TONNAGE.

The traffic on this reach of the St. Francis River is carried on by steamers of draft not exceeding 2 feet light, towing barges, which are loaded in busy seasons to 4 feet. It centers at St. Francis, Ark., near the State boundary, where are lumber and stave mills. Rough lumber is rafted from above that point and towed from below, and supplies are taken thence to the camps; the finished lumber and staves are sent out by rail.

The river is crossed at Wappapello by the Cape Girardeau and Fort Smith Railway; at Poplin by the Poplar Bluff and Cairo Branch of the St. Louis, Iron Mountain and Southern Railway, and at St. Francis by the St. Louis Southwestern Railway.

APPROPRIATIONS AND EXPENDITURES.

This reach of the river is understood not to have been included in the snagging operations under the early appropriations for snagging in Western rivers.

Its specific appropriations and other funds are as follows:

Appropriation August 11, 1888	$5,000.00
Appropriation September 19, 1890	10,500.00
Received, sale of U. S. snag boat *Missouri*	3,000.00
Total	18,500.00
Expended to June 30, 1892	15,516.01

Money statement.

July 1, 1893, balance unexpended	$2,983.99
June 30, 1894, amount expended during fiscal year	802.56
July 1, 1894, balance unexpended	2,181.43
July 1, 1894, outstanding liabilities	5.00
July 1, 1894, balance available	2,176.43

Expense account.

Pay roll	$512.49	Office rent	$85.00
General supplies	10.55	Telegrams	.32
Subsistence	17.94	Stationery	3.00
Transportation	10.80	Reserved in U. S. Treasury for freight charges	63.46
Traveling expenses	34.00		
Fuel	50.00		
Telephone rent	15.00	Total	802.56

COMMERCIAL STATISTICS.

The river was reported navigable to Greenville, Mo., in high water; navigable all the year between St. Francis and Brown's Ferry. The rafting season began in February.

List of steamboats engaged in navigation, St. Francis River, Mo., June 1, 1893, to May 31, 1894.

Name.	Class.	Tonnage.	Draft.		Between—	Round trips.	Passengers.
			Light.	Loaded.			
			Ft. in.				
Milt Jones and barges	Stern-wheel	25	1 8	.....	No report	.....	.....
Emma No. 2, and barges.	....do	19.34	2 0	.....	St. Francis and stave camps.	200	.....
					St. Francis and Stolpers Landing.	34	
					St. Francis and Enletts.	20	
S. A. Stroud and barges.	....do	35.28	1 8	.....	St. Francis and Browns Ferry.	8	150
					St. Francis and various points above and below.	49	

Statement of commerce reported.

	Tons.
Lumber	3,402
Staves and stave bolts	20,275
Provisions	6
Grain	180
Miscellaneous freights	160
Spokes	1,901
Saw logs (towed by steamers)	4822
Saw logs (rafted)	9,400
Total	35,826

APPENDIX X.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS, OF HARBOR AT ST. LOUIS, MO., OF GASCONADE AND OSAGE RIVERS, MISSOURI, AND OF KASKASKIA RIVER, ILLINOIS.

REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from Mississippi River.
2. Mississippi River between Ohio and Missouri rivers.
3. Harbor at St. Louis, Mo.
4. Gasconade River, Missouri.
5. Osage River, Missouri.
6. Kaskaskia River, Illinois.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 7, 1894.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

XI.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER.

Before this work was inaugurated the navigation of the river was very much interfered with by numerous snags, logs, etc., which had lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks, dangerous to navigation, also occupied the channel. For the removal of these obstructions appropriations were made as early as 1824, and the project adopted consisted of building boats suitable for removing the

snags, etc., and operating them whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose can not be definitely given as, previous to the appropriations made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required.

Congress, by act of March 3, 1879, appropriated the first specific sum for removing snags, wrecks, etc., from the Mississippi River, and that appropriation was followed by others until 1888 when, by the act of August 11 of that year, an annual expenditure not to exceed $100,000 for this purpose was authorized. Under that act operations have since been carried on annually.

The two snag boats, the *H. G. Wright* and the *J. N. Macomb*, after undergoing some minor repairs, proceeded upon their annual work of removing obstructions. The *Wright*, under command of Capt. R. E. Birch, commenced work on August 1, 1893, and operated continuously between the mouth of the Missouri River and Memphis until March 27, 1894.

The *Macomb*, under command of Capt. A. H. Stewart, began work on July 3, 1893, and operated continuously between Memphis and Natchez (making one trip, however, as far down the river as New Orleans) until March 12, 1894.

During the past spring both boats underwent some necessary repairs to fit them for further work. The wheelhouses of the *Macomb* were replated with steel sheets and a new electric-light plant was added to the *Wright*.

The *Wright* was built in 1880 and the *Macomb* in 1874. They were both designed and built by Maj. (now Lieut. Col.) Suter of the Corps of Engineers. The following general description of the *Macomb* and of its method of operating will answer for both boats, the *Wright* only differing from the *Macomb* in having the benefit of some improvements suggested by experience.

The boat is of iron, 178 feet long and 90 feet wide over wheel guards; it has twin bows separated by an open space 12 feet wide, called a well, which extends 65 feet aft from the stems. The speed of the boat is 8½ miles per hour in still water with engines of 600-horse power. A steel butting beam 22 feet long, 7 feet wide, and 16 inches thick spans the space between the bows near the stems at the surface of the water. The end of a snag is lifted onto this beam by means of a sweep chain which is hung as a loop from one stem to the other, or by means of tackle hung from sheer poles which stand over the beam like the letter A. Four steam capstans, each capable of a direct pull of 35 tons and a speed of 30 feet per minute, supply the power for operating the appliances and also for pulling the snag in its inclined position upon the beam. To aid in this there is added a powerful purchase fitted with a cast-iron drum winding a chain with links made of iron 2¼ inches in diameter. This chain is tested at 75 tons, but is often broken in the work to which it is subjected. The combined pulling power of this purchase and the four capstans is 225 tons; but this is quite insignificant when compared with the work accomplished by butting, using the whole boat as a hammer of 800 tons weight. The snag being drawn upon the beam and an after roller, which also bridges the well, it is sawn into logs by powerful steam saws, one working over the roller and one over the forward edge of the butting beam. The after saw reduces the body of the tree to logs that are dropped anywhere, as they will float away, but the large root, matted with clay and gravel and sometimes

feet in diameter by 3 or 4 feet thick, is carefully dropped into some ep hole or a place well out of the channel of the river.

In cases of great difficulty the hydraulic jet, and dynamite are occa›nally employed as auxiliaries in loosening the root of the snag.

The amount of work accomplished by the two boats during the past cal year is given in the following table:

Name of snag boat.	Snags pulled.	Leaning trees cut.	Drift piles removed.	Wrecks removed.	Miles run.
G. Wright	1,386	13,023	12	5	6,378
N. Macomb	1,671	9,838	7	.....	8,958
Total	3,057	22,861	19	5	15,336

The wrecks removed by the *Wright* are as follows:

At Island No. 40.—Two coal boats entirely removed; one steamboat ull loaded with coal partially removed.

At Cherokee Crossing.—One stone boat entirely removed.

At Thompsons Crossing.—Steamboat *Ægis*, boilers taken out, hull lown up, and partially removed.

The trees referred to are generally leaning timber in bends of the iver or trees that are liable to fall into the stream and become obstruc›ions.

The work accomplished by the snag boats is of great benefit to the avigation of the river. Formerly the sinking of steamboats by run›ing on snags was of frequent occurrence, but since the snag boats have een regularly at work such wrecks are seldom heard of.

An annual appropriation of an amount not to exceed $100,000 having ›en made for the work, the snag boats will patrol the river whenever ›cessary in order to keep the channel free from obstructions, such as ›ags, logs, drift piles, leaning trees, and such small wrecks as they ›y occasionally be enabled to handle. The removal of large, heavy, numerous wrecks by the snag boats is not contemplated, the boats t being built for such purpose or for wrecking. The removal of ›ecks from the channels, in general, is provided for by a specific act Congress.

Amount expended on this work to June 30, 1893, under all specific d annual appropriations, including that of March, 1879, $930,758.

Amount expended on the work during the fiscal year ending June 30, 94, $88,116.22, a detailed statement of which expenditures is given the accompanying tables Nos. 1 and 2.

The hull of the *Wright*, which has done good service, is in very bad ndition, and without extensive repair, in fact, almost if not complete ›ewal of the plating, can not be counted upon for service for more an a year or so longer. Many of the iron plates are badly corroded, d should be replaced as soon as possible by steel ones, and the hull ›uld be strengthened in parts.

For statistics of commerce benefited by the snag-boat operations ference must be made to the statistics of the Mississippi River from e mouth of the Missouri River to New Orleans.

Appropriations made by Congress for removing obstructions in Mississippi River.

By act of—		For fiscal year ending June 30—	
March 3, 1879	$100,000.00	1890	†$49,069.
June 14, 1880	100,000.00	1891	92,720.
March 3, 1881	80,000.00	1892	98,250.
August 2, 1882	85,000.00	1893	96,497.
July 5, 1884	*72,950.63	1894	88,252.
August 5, 1886	56,250.00		
August 11, 1888	100,000.00	Total	1,019,010.

Money statement.

Amount drawn under section 7, act of August 11, 1888	$100,000.
June 30, 1894, amount expended during fiscal year	88,116.
June 30, 1894, outstanding liabilities	136.
June 30, 1894, amount to revert to Treasury	11,747.
July 1, 1894, amount available for fiscal year 1894–'95	100,000.

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work removing obstructions in Mississippi River during fiscal year 1894, as required by sect 7 of the river and harbor act of August 11, 1888.*

Month.	Voucher.	To whom paid.	For what paid.	Amou
1893.				
July...	48	Hired men	Services	$227
	105	....do	....do	478
	108	....do	....do	1,553
	109	....do	....do	290
	112	....do	....do	1,490
	113	....do	....do	74
	114	John Ranciville	....do	5
Aug...	48	E. E. Furney	Traveling expenses	10
	70	The Carnegie Steel Co., Limited	Channel steel, etc	15
	77	The Pond Machinery Co	Valve seats	100
	99	J. D. Streett & Co	Oils	61
	105	Hired men	Services	475
	131	Goodyear Rubber Co	Supplies	21
	132	Day Rubber Co	Boots, etc	20
	133	Crown Coal and Tow Co	Coal	58
	134	Ewald Iron Co	Iron	18
	135	Anchor Line Store	Outfit and supplies	93
	136	Wm. Barr Dry Goods Co	Outfit	53
	137	Chas. W. Barstow	Outfit, paint, etc	29
	138	Fulton Iron Works	Repairs, etc	36
	139	Huse & Loomis Ice and Transportation Co.	Ice	84
	140	Gust. Bischoff	Subsistence	363
	141	David Nicholson	Subsistence	615
	142	Peter Nicholson & Sons	....do	724
	143	Henry A. Koettker	....do	258
	144	Elwell & Ward	....do	42
	145	Dougherty-Crouch Drug Co	Medicines, etc	1
	146	J. S. Merrell Drug Co	Alcohol, etc	13
	147	Meyer Bros. Drug Co	Medicines	27
	148	Page & Tolkacz	Scuppers	18
	149	Samuel Cupples Woodenware Co	Rope	305
Sept...	1	Hired men	Services	1,397
	2	....do	....do	805
	3	....do	....do	1,855
	4	....do	....do	330
	74	Kupferle Bros. Manufacturing Co	Brass unions	9
	75	Wyeth Lumber Co	Lumber	74
	76	The Consolidated Coal Co. of St. Louis	Coal	136
	77	St. Louis Ore and Steel Co	....do	113
	78	Merchants Laundry Co	Laundry work	17
	79	M. M. Buck & Co	Polish, etc	9
	81	James Ward & Son	Packing, etc	57
	87	P. T. Langan	Lumber	46
	88	G. D. Williamson	Nails, etc	7

* This appropriation was for $75,000, $72,950.67 of which was used on this work.

† Section 7, act of August 11, 1888, provides for a yearly appropriation of $100,0 or as much thereof as may be necessary, for the purpose of removing snags, wreck and other obstructions from the Mississippi River.

ABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

onth.	Voucher.	To whom paid.	For what paid.	Amount.
1893.				
pt...	89	The Oliver-Finnie Grocer Co	Subsistence	$32.40
	90	Pittsburg Coal Co	Coal	650.00
	91	James A Tappan	....do	480.00
	92	Southern Express Co	Express charges	2.83
	117	Chas. J. Allen, major, Corps of Engineers	Mileage	20.32
	121	Hired men	Services	528.00
et....	21	....do	....do	1,375.00
	22	....do	....do	801.17
	23	....do	....do	1,769.50
	24	....do	....do	385.56
	135	Anchor Line Store	Outfit and supplies	49.59
	136	Wm. Barr Dry Goods Co	Cloth	3.60
	137	Big Muddy Coal and Iron Co	Coal	146.25
	138	Gust. Bischof	Subsistence	138.50
	139	Wm. Barnard	Coal	19.80
	140	Chas. W. Barstow	White lead, etc	32.93
	141	The W. A. Bonsack Lumber Co	Lumber	83.79
	142	M. M. Buck & Co	Brooms, etc	4.08
	143	Cairo City Coal Co	Coal	108.00
	144	....do	....do	72.00
	145	The Consolidated Coal Co. of St. Louis	....do	274.50
	146	J. H. Coffin & Co	Supplies	46.33
	147	Harry C. Dance	Services	6.19
	148	Ewald Iron Co	Iron	194.92
	149	Flachman & Matthews	Oils	33.77
	150	John J. Ganahl Lumber Co	Lumber	59.61
	151	Gibbons & Hirsch	Subsistence	60.68
	152	Goodyear Rubber Co	Packing and boots	20.38
	153	C. Kney	Subsistence	104.96
	154	L. S. Koerber	....do	118.10
	155	Henry A. Koettker	....do	95.90
	156	J. Kennard & Sons Carpet Co	Linoleum	48.10
	157	Matt Monaghan & Co	Subsistence	159.85
	158	....do	....do	46.68
	159	Natchez Ice Co	Ice, etc	47.50
	160	National Tube Works Co	Pipe, etc	3.54
	161	N. O. Nelson Manufacturing Co	Steam fittings	45.37
	162	Nixdorf-Krein Manufacturing Co	Chain	84.88
	163	Pittsburg Coal Co	Coal	250.00
	164	Peatross, Cameron & Co	....do	491.20
	165	Peterson & Homes	Dishes	9.30
	166	Platt & Thornburgh Paint and Glass Co	Paints, etc	9.67
	167	The Wm. Powell Co	Valves	6.60
	168	Valentine Resch	Subsistence	52.70
	169	John F. Rennie	Siphon	4.75
	170	Scarritt Furniture Co	Chairs, mattresses, etc	126.50
	171	Simmons Hardware Co	Hardware, etc	104.24
	172	Carl Setz	Subsistence	16.50
	173	E. E. Souther & Bro	Iron and rivets	28.21
	174	Jacob Walter	Subsistence	33.32
	175	Wrought Iron Range Co	Range castings	15.75
	176	Whitelaw Brothers	Turpentine	17.90
	177	Western Anthracite Coal Co	Coal	11.00
	178	The Carnegie Steel Co., Limited	Steel	59.22
	179	Fulton Iron Works	Worm wheels	304.75
	180	....do	Castings	27.15
	181	Huse & Loomis Ice and Transportation Co.	Ice	29.97
	182	Page & Tolkacz	Repairs	8.15
	183	Parker Stationery Co	Record book, etc	10.70
	184	Ripley & Bronson	Steam fittings, etc	162.92
	185	Revere Rubber Co	Packing	5.70
	186	Geo. A. Rubelmann Hardware Co	Hardware	18.39
	187	St. Louis Metal and Supply Co	Gum packing, canvas, etc	110.08
	188	Jacob Walter	Subsistence	56.28
	193	Moffett-West Drug Co	Medicines	17.54
	194	Paddock-Hawley Iron Co	Iron, steel, etc	28.98
	196	Albert L. Butler	Coal and spars	75.00
	223	Western Union Telegraph Co	Telegrams	6.69
	234	Hired men	Services	500.00
	235	....do	....do	1,808.00
	236	....do	....do	367.00
ov...	6	....do	....do	1,367.00
	7	....do	....do	797.66
	35	Western Union Telegraph Co	Telegrams	1.64
	49	C. Schultze	Dynamite	5.00
	74	James Parker	Services	10.83
	75	Frank J. Isam	....do	12.00
	76	Emery Seaymour	....do	14.00
	77	Wm. Clark	....do	18.67

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1893.				
Nov ...	78	Branch-Crookes Saw Co	Saws	$25.20
	79	L. M. Rumsey Manufacturing Co	Wrench	5.15
	80	N. O. Nelson Manufacturing Co	Globe valves	30.40
	81	Western Iron and Supply Co	Valves	2.80
	82	Simmons Hardware Co	Shears	1.50
	83	Paddock-Hawley Iron Co	Iron and steel	55.07
	84	E. E. Souther & Bro	Steel plates, etc	19.05
	85	Ripley & Bronson	Steam fittings	3.55
	86	Chas. W. Barstow	Supplies	13.88
	87	James Ward & Son	....do	57.23
	88	Anchor Line Store	....do	86.04
	89	The Consolidated Coal Co. of St. Louis	Coal	115.05
	90	Albert L. Butler	....do	25.00
	91	Matt Monaghan & Co	Subsistence	122.04
	92	Henry A. Koettker	....do	14.70
	93	Peter Nicholson & Sons	....do	397.43
	94	Huse & Loomis Ice and Transportation Co.	Ice	14.22
	95	Big Muddy Coal and Iron Co	Coal	130.00
	96	James A. Tappan	....do	160.00
	97	Cairo City Coal Co	....do	192.00
	98	Pittsburg Coal Co	....do	497.50
	99	Valentine Resch	Subsistence	86.00
	132	J. S. Merrell Drug Co	Quinine	14.00
	142	Chas. Kney	Subsistence	102.92
	143	Chas. F. Luehrmann Hardwood Lumber Co.	Lumber	9.24
	156	John J. Ganahl Lumber Co	....do	14.08
	183	The Ætna Powder Co	Dynamite	42.68
	184	Excelsior Manufacturing Co	Stoves, etc	34.10
	185	Chas. W. Barstow	Brushes	8.78
	186	Pentland & Hahn	Bell handles	3.50
	187	Simmons Hardware Co	Clothes wringer	6.00
	188	Geo. A. Rubelmann Hardware Co	Nails	.49
	189	Fulton Iron Works	Derrick shoes	25.55
	190	St. Louis Engineering Co	Lamps	10.25
	191	Page & Tolkacz	Stove pipe, etc	37.70
	192	N. O. Nelson Manufacturing Co	Unions, etc	1.27
	193	St. Louis Metal & Supply Co	Outfit and supplies	35.76
	194	J. H. Coffin & Co	....do	149.37
	195	The Consolidated Coal Co. of St. Louis	Coal	115.50
	196	Big Muddy Coal and Iron Co	....do	133.12
	197	W. H. Brown's Sons	....do	150.00
	198	Cairo City Coal Co	....do	200.00
	199	Peatross, Cameron & Co	....do	280.00
	200	James A. Tappan	....do	320.00
	201	Pittsburg Coal Co	....do	737.50
	202	Natchez Ice Co	Ice	14.00
	203	Huse & Loomis Ice and Transportation Co.	....do	13.77
	204	Henry McGeary	Subsistence	21.55
	205	Joseph Hirsch	....do	34.97
	206	Williams & Schevenell	....do	39.18
	207	Valentine Resch	....do	55.90
	208	L. S. Koerber	....do	72.72
	209	Matt. Monaghan & Co	....do	286.76
	210	The Oliver-Finnie Grocer Co	....do	519.88
	211	Gust. Bischof	....do	274.12
Dec....	2	Hired men	Services	403.00
	3	....do	....do	978.17
	4	....do	....do	1,175.00
	5	....do	....do	1,834.00
	6	....do	....do	336.33
	28	Jacob Walter	Subsistence	66.71
	29	Valentine Resch	....do	37.97
	30	Fred Munz	....do	47.18
	31	Jacob Walter	....do	88.29
	32	....do	....do	71.89
	41	John F. Rennie	Fire brick	2.75
	42	Cairo City Coal Co	Coal	190.40
	43	Albert L. Butler	....do	35.00
	44	Lee Bros	Oil	6.50
	54	R. & T. A. Ennis Stationery Co	Stationery	3.50
	109	Chas. Kney	Subsistence	73.92
	110	J. D. Lawnin	Lumber	11.88
	111	The Oliver-Finnie Grocer Co	Subsistence	262.63
	112	Henry A. Koettker	....do	65.30
	113	Baldwin, Knowlton & Lake	....do	178.22
	114	Williams & Schevenell	....do	68.60
	115	Matt Monaghan & Co	....do	374.98
	116	Peter Nicholson & Sons	....do	42.47

ABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1893.				
Dec....	117	Big Muddy Coal and Iron Co	Coal	$87.75
	118	Pittsburg Coal Co	....do	543.75
	119	E. E. Souther & Bro	Iron and steel	23.96
	120	Lee Bros	Supplies	28.22
	121	James A. Tappan	Coal	500.00
	122	Anchor Wrecking Co	Services of diver, etc	50.00
	127	Peatross, Cameron & Co	Coal	140.00
	128	L. S. Koerber	Subsistence	50.54
	129	Gust. Bischoff	....do	43.34
	130	Joseph Hirsch	....do	48.75
	152	Day Rubber Co	Packing	1.41
	158	E. H. Bruce	Subsistence	4.04
1894.				
Jan....	2	Hired men	Services	500.00
	17	....do	....do	1,408.00
	18	....do	....do	766.00
	19	....do	....do	1,822.17
	20	....do	....do	340.83
	28	Edward Culver	Traveling expenses	10.50
	31	Western Union Telegraph Co	Telegrams	5.62
	52	Baldwin, Knowlton & Lake	Subsistence	87.40
	53	Chas. Kney	....do	129.04
	54	Jacob Walter	....do	92.40
	55	Valentine Resch	....do	81.08
	56	The Oliver-Finnie Grocer Co	....do	436.31
	57	Matt. Monaghan & Co	....do	192.53
	58	Joseph Hirsch	....do	54.78
	59	Wood & Bennett	....do	68.28
	60	L. S. Koerber	....do	23.70
	61	Huse & Loomis Ice and Transportation Co.	Ice	11.34
	62	Peatross, Cameron & Co	Coal	328.13
	63	James A. Tappan	....do	320.00
	64	Pittsburg Coal Co	....do	865.00
	65	The Consolidated Coal Co. of St. Louis	....do	106.50
	66	Big Muddy Coal and Iron Co	....do	48.75
	67	Cairo City Coal Co	....do	375.10
	68	Bedford & Holloway	Wood	9.00
	69	Wrought Iron Range Co	Grate	2.10
	70	Western Stove Manufacturing Co	....do	1.02
	71	J. H. Coffin & Co	Outfit and supplies	369.64
	72	Ewald Iron Co	Steel	25.38
	73	Simmons Hardware Co	Outfit	3.00
	74	W. & S. Jack	....do	13.11
	75	Lee Brothers	Oils, etc	21.48
	76	Dean & Carroll Co	White lead, etc	34.60
	84	Hired men	Services	553.00
	85	....do	....do	925.00
	86	....do	....do	1,225.00
	87	....do	....do	1,728.83
	88	....do	....do	420.00
eb....	11	Wood & Bennett	Supplies and subsistence	26.03
	12	Jacob Walter	Subsistence	102.59
	13	Valentine Resch	....do	106.23
	14	W. W. Pinnell	....do	19.44
	15	Cairo City Coal Co	Coal	205.30
	16	Albert L. Butler	....do	60.00
	17	J. H. Coffin & Co	Chains, etc	56.38
Iar....	2	Hired men	Services	500.00
	8	Chas. J. Allen, major, Corps of Engineers	Mileage	63.52
	16	Lawrence Whetts	Services	6.00
	17	Arthur Graham	Wood	19.50
	23	Hired men	Services	1,739.00
	24	....do	....do	372.00
	25	....do	....do	1,175.00
	26	....do	....do	953.83
	31	Baldwin, Knowlton & Lake	Subsistence	89.99
	32	Evander Williams & Co	....do	54.12
	33	Joseph Hirsch	....do	75.79
	34	Chas. Kney	....do	52.50
	35	L. S. Koerber	....do	61.60
	36	Matt Monaghan & Co	....do	256.62
	37	....do	....do	124.80
	38	The Oliver-Finnie Grocer Co	....do	315.91
	39	Valentine Resch	....do	33.38
	40	C. Schultze	....do	15.44
	41	B. W. Tackenberg	....do	11.25
	42	Cairo City Coal Co	Coal	108.50
	42	Peatross, Cameron & Co	....do	320.00
	44	Pittsburg Coal Co	....do	670.00

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amou
1894.				
Mar...	45	James A. Tappan	Coal	$240
	46	....do	....do	280
	47	J. H. Coffin & Co	Supplies, etc	139
	48	Lee Brothers	....do	17
	49	Fulton Iron Works	Liner boxes	45
	50	Dan Shea & Co	Repairs	23
	100	Big Muddy Coal and Iron Co	Coal	113
	101	M. J. Crocker	Subsistence	15
	102	Joseph Hirsch	....do	74
	103	Knapp Brothers	....do	42
	104	L. S. Koerber	....do	38
	105	Fred Muns	....do	42
	106	David Nicholson	....do	18
	107	The Oliver-Finnie Grocer Co	....do	36
	108	Peatross, Cameron & Co	Coal	175
	109	Pittsburg Coal Co	....do	860
	110	J. D. Streett & Co	Oil	15
	111	Jacob Walter	Subsistence	36
	113	Hired men	Services	544
	116	Evander Williams & Co	Subsistence	73
	119	St. Louis, Iron Mountain and Southern Rwy. Co.	Commutation ticket	12
	123	Hired men	Services	553
	124	....do	....do	1,315
	125	....do	....do	802
	126	....do	....do	1,256
	63	Western Union Telegraph Co	Telegrams	10
	64	Hired men	Services	232
	65	St. Louis, Iron Mountain and Southern Rwy. Co.	Commutation ticket	12
	85	Valentine Resch	Subsistence	17
	86	Evander Williams & Co	....do	28
	87	Walter & Co	....do	64
	88	Wood & Bennett	....do	8
	89	Cairo City Coal Co	Coal	94
	90	Western Union Telegraph Co	Telegrams	23
	95	....do	....do	12
	142	E. E. Souther & Bro	Rivets	12
	143	Anchor Line Store	Brooms, oil, lead, etc	115
	144	Ripley-Detrick Supply Co	Steam fittings	27
	145	Ringen Stove Co	Fire pot, etc	8
	146	Huse & Loomis Ice and Transportation Co	Ice	26
	147	Geo. A. Rubelmann Hardware Co	Handles, etc	7
	148	Ewald Iron Co	Iron, etc	20
	149	M. M. Buck & Co	Crucible	1
	150	Wm. Barr Dry Goods Co	Outfit	60
	151	J. D. Streett & Co	Oils	33
	152	St. Louis Metal and Supply Co	Oils, etc	15
	153	James Ward & Son	Brushes, paint, etc	103
	154	Chas. W. Barstow	....do	98
	155	The W. A. Bonsack Lumber Co	Lumber	170
	156	Silvester Coal Co	Coal	10
	157	Crown Coal and Tow Co	....do	60
	158	The Consolidated Coal Co	....do	208
	159	Big Muddy Coal and Iron Co	....do	343
	160	Gust. Bischof	Subsistence	192
	161	Matt Monaghan & Co	....do	54
	162	Henry A. Koettker	....do	100
	163	Peter Nicholson & Sons	....do	414
	164	Peterson & Homes	Dishes	7
	165	Whitelaw Brothers	Turpentine	6
	166	John J. Ganahl Lumber Co	Lumber	9
	167	Robt. A. Schlegel & Bro	Mirror	3
	168	Chas. Kney	Subsistence	30
	169	Matt. Monaghan & Co	....do	50
	170	Cairo City Coal Co	Coal	57
	171	James A. Tappan	....do	140
	172	Pittsburg Coal Co	....do	336
	185	The Knapp-Stout & Co. Company	Lumber	16
	186	Hired men	Services	500
	194	Simmons Hardware Co	Outfit and supplies	18
	195	Buxton & Skinner Stationery Co	Invoice book	3
	196	Zittlosen Tent and Awning Co	Flag	9
May...	1	Hired men	Services	1,325
	2	....do	....do	1,511
	70	St. Louis, Iron Mountain and Southern Rwy. Co.	Commutation ticket	12
	77	....do	....do	12
	159	The W. A. Bonsack Lumber Co	Lumber	67
	160	John J. Ganahl Lumber Co	....do	33
	161	Gust. Bischoff	Subsistence	288

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1894.				
May	162	Henry A. Koettker	Subsistence	$175.83
	163	David Nicholson	....do	153.92
	164	Peter Nicholson & Sons	....do	19.93
	165	Anchor Line Store	Oils, etc	219.42
	166	Chas. W. Barstow	Shellac, etc	6.29
	167	Ewald Iron Co	Iron and steel	39.10
	168	H. L. Fox & Co	Salamoniac, etc	1.05
	169	Geo. J. Fritz	Castings	35.44
	170	Huse & Loomis Ice and Transportation Co.	Ice	40.73
	171	N. O. Nelson Manufacturing Co	Governor	10.00
	172	Platt & Thornburgh Paint and Glass Co.	Vermilion	1.25
	173	Paddock-Hawley Iron Co	Rivets	9.88
	174	Ripley-Detrick Supply Co	Drills, iron, etc	8.90
	175	John Rohan	Material and labor	148.85
	176	Simmons Hardware Co	Tacks	3.63
	177	James Ward & Son	White lead, mallet, etc	179.72
	178	Jos. F. Wangler Boiler and Sheet Iron Works Co.	Steel plates, etc	80.98
	179	Zittlosen Tent and Awning Co	Duck	208.20
	180	Chester Harding, second lieutenant, Corps of Engineers.	Mileage	4.00
	187	Hired men	Services	553.00
June	2	....do	....do	1,390.00
	3	....do	....do	1,492.50
	52	Oscar Setz	Subsistence	15.75
	122	Anchor Line Store	Outfit and supplies	58.03
	123	Wm. Barr Dry Goods Co	Outfit, etc	48.00
	124	R. Bush	Subsistence	10.80
	125	Henry A. Koettker	....do	274.44
	126	David Nicholson	....do	171.85
	127	Oscar Setz	....do	18.75
	128	K. B. Stowe & Co	....do	141.29
	129	Ward Bros	....do	23.59
	130	....do	....do	27.65
	131	James Beakey Stove Co	Outfit	4.75
	132	M. M. Buck & Co	Outfit and supplies	22.24
	133	Chas. W. Barstow	Beeswax, etc	9.50
	134	Berthold & Jennings	Lumber	26.89
	135	The Consolidated Coal Co., of St. Louis	Coal	109.51
	136	J. S. Costello & Son	Paint brushes	2.50
	137	....do	Brushes, etc	10.55
	138	Goodyear Rubber Co	Hose and packing	39.85
	139	Huse & Loomis Ice and Transportation Co.	Ice	67.50
	140	Moffitt West Drug Co	Supplies	17.50
	141	Paddock-Hawley Iron Co	Rivets	1.75
	142	Peters Rubber and Supply Co	Packing	3.55
	143	Ripley-Detrick Supply Co	Rivets	13.13
	144	....do	Rivets, etc	14.21
	145	John Rohan	Steam drum	39.00
	146	L. M. Rumsey Manufacturing Co	Black pipe, etc	10.94
	147	Sligo Iron Store Co	Nuts, iron, etc	32.31
	148	Scarritt Furniture Co	Perforated seats	5.90
	149	J. D. Streett & Co	Oils, etc	97.95
	150	Western Iron and Supply Co	Rivets	23.04
	151	Western Brass Manufacturing Co	Angle valves	1.85
	152	James Ward & Son	Outfit and supplies	56.89
	153	Whitelaw Bros	Red lead, oil, etc	38.19
	154	Anchor Line Store	Outfit and supplies	184.01
	155	Berry-Horn Coal Co	Coal	16.20
	156	Branch Crookes Saw Co	Saws	81.50
	157	Samuel Cupples Wooden Ware Co	Outfit and supplies	20.71
	158	Henry A. Koettker	Subsistence	166.10
	159	David Nicholson	....do	12.50
	160	Missouri Glass Co	Crockery	3.84
	161	New York Belting and Packing Co	Hose, rubber boots, etc	37.08
	162	Peterson & Homes	Dishes	.88
	163	Paddock-Hawley Iron Co	Iron, steel, etc	90.94
	164	Geo. A. Rubelmann Hardware Co	Outfit and supplies	2.54
	165	James Ward & Son	....do	255.28
	166	Western Iron and Supply Co	Pumps and iron	16.05
	167	E. H. Warner & Son	Lumber	108.54
	168	Simmons Hardware Co	Outfit and supplies	116.42
	175	Hired men	Services	500.00
	176	....do	....do	1,420.83
	177	....do	....do	1,413.34
	178	Ewald Iron Co	Iron, etc	32.50
	179	Huse & Loomis Ice and Transportation Co.	Ice	108.00
	180	Paddock-Hawley Iron Co	Nuts	8.63
	181	J. S. Merrell Drug Co	Supplies	7.39
	182	Schulenberg & Boeckler Lumber Co	Lumber	7.78
	183	Gust. Bischoff	Subsistence	198.92

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid	Amount.
1894.				
June...	184	Peter Nicholson & Sons	Subsistence	$52.38
	185	Platt & Thornburgh Paint and Glass Co..	Zinc	17.95
	186	Page & Tolkacz	Soup pans	2.10
	187	Schultz Belting Co	Belt	42.47
	188	R. B. Gray China Co	Crockery	22.10
	189	F. A. Drew Glass Co	Glass	9.35
	190	Geo. J. Fritz	Castings	22.85
	191	Eau Claire-St. Louis Lumber Co	Lumber	101.08
	220	Gust. Bischoff	Subsistence	199.01
	221	The Carnegie Steel Co., Limited	Steel	177.82
	222	Ewald Iron Co	Iron and steel	65.40
	223	Flachman & Matthews	Paint	5.50
	224	H. L. Fox & Co	Carriage bolts	1.10
	226	....do	Outfit and supplies	28.31
	227	Heckel Hardware Co	....do	19.42
	228	Wrought Iron Range Co	Range, etc	118.05
	229	The Albert Webb Supply Co	Steam fittings	29.29
	231	Thos. Sexton & Co	Outfit	76.56
		Total expended		88,116.22
		Outstanding liabilities June 30, 1894.		
		John J. Ganahl Lumber Co	Lumber	11.72
		....do	....do	53.82
		Oscar Setz	Subsistence	18.24
		Flachman & Matthews	Supplies	24.53
		Glidden & Joy	Paint	8.50
		Fulton Iron Works	Castings	15.08
		Wm. Jessop & Sons	Rivets	4.35
		Total outstanding		136.24
		Total expended and outstanding		88,252.46

TABLE NO. 2.—*Summary of expenses for operating United States snag boats H. G. Wright and J. N. Macomb, in connection with the work of removing obstructions in Mississippi River during fiscal year ending June 30, 1894.*

Application.	1893.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Office expenses	$275.00	$275.00	$328.00	$306.89	$1.64	$203.00
Supervision	200.00	210.00	220.32	200.00	.....	200.00
Expenses of snag boat H. G. Wright:						
Crew	1,852.98	.....	2,203.17	2,182.36	2,220.16	2,203.17
Outfit	.....	305.73	17.90	204.68	98.75	.....
Fuel	.....	.....	136.50	873.55	1,258.17	313.15
Subsistence	.....	996.66	.....	572.29	970.86	584.36
Supplies	.....	45.01	16.20	206.04	230.18	7.91
Repairs	.....	157.62	11.80	738.96	205.32	38.59
Miscellaneous	.....	28.68	.....	5.88	7.00	.....
Expenses of snag boat J. N. Macomb:						
Crew	1,806.01	.....	2,185.00	4,330.00	.....	2,170.33
Outfit	.....	78.33	5.04	141.85	21.55	.....
Fuel	.....	58.23	1,243.75	574.20	1,797.50	1,183.75
Subsistence	.....	1,093.26	32.40	388.65	1,099.30	940.37
Supplies	.....	88.00	24.70	85.75	118.23	.....
Repairs	.....	112.00	146.42	392.37	9.59	28.22
Miscellaneous	.....	2.57	2.83	11.66	7.00	3.50
Total	4,133.99	3,451.09	6,574.03	11,215.13	8,045.25	7,876.35

TABLE NO. 2.—*Summary of expenses for operating United States snag boats H. G. Wright and J. N. Macomb, etc.*—Continued.

Application.	1894.						
	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
Office expenses	$658.62	.....	$653.00	$350.06	$353.00	$300.00	$3,704.21
Supervision	410.50	.....	463.52	212.25	228.50	200.00	2,545.09
Expenses of snag boat H. G. Wright:							
Crew	4,324.00	.....	3,450.00	232.82	1,325.83	2,810.83	22,804.82
Outfit	36.31	$47.28	.....	91.13	.....	110.80	912.58
Fuel	964.35	265.30	1,211.75	693.62	.....	49.56	5,765.95
Subsistence	893.93	240.08	701.02	756.72	209.02	752.24	6,678.08
Supplies	236.70	22.41	24.34	112.58	1.05	226.51	1,128.93
Repairs	60.73	.....	68.24	81.39	922.60	438.14	2,723.39
Miscellaneous	.....	.....	.....	.....	.....	.....	41.56
Expenses of snag boat J. N. Macomb:							
Crew	4,311.83	.....	4,755.00	.....	1,511.00	2,905.84	23,975.01
Outfit	23.15	.....	7.00	34.24	1.26	457.42	769.84
Fuel	1,088.13	.....	1,575.00	515.37	.....	76.15	8,112.08
Subsistence	396.37	.....	761.41	238.68	449.02	754.53	6,154.89
Supplies	.....	.....	149.95	145.54	11.94	592.76	1,216.87
Repairs	.....	.....	.....	279.94	116.48	594.33	1,679.35
Miscellaneous	.....	.....	12.25	.....	.....	.....	39.81
Total	13,404.62	575.97	13,832.48	3,744.34	5,130.10	*10,269.11	*88,252.46

* Includes $136.24, liabilities incurred during the fiscal year but remaining unpaid on June 30, 1894.

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

The object of the improvement is to obtain a minimum depth at standard low water of 6 feet from the mouth of the Missouri River to St. Louis, a distance of 16 miles, and of 8 feet at the same stage of water from St. Louis to the mouth of the Ohio River, 178 miles, the natural depth being in many cases from 3½ to 4 feet. The channel is divided at a number of points by islands forming sloughs and secondary channels behind them, through which a good deal of the volume of flow is diverted to the detriment of navigation.

The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, proceeding downstream from that city.

The first work for improvement began in 1872 and was continued for a number of years as appropriations were made, the works consisting of dikes and dams of brush and stone, erected with a view to confining the low-water volume to one channel, and of revetments to hold and preserve the banks where necessary or advisable.

The present project is a continuation of the plan adopted in 1881, and contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles. The method employed is the building up of new banks out to the line desired from the solid matter brought down by the river and which is collected by means of hurdles. The banks, both new and old, are revetted where necessary.

A hurdle, as the term is here used, is one of many silt-arresting devices that have been experimented upon in this country and elsewhere. The hurdle consists, essentially, of a row, or of parallel rows,

of piling, the piles driven either singly or in clumps, the piling being connected lengthwise of the hurdle by wattling of fine brush, or by curtains composed of brush and lodged against the upstream side of one of the rows of piles, the whole forming a permeable dike through which the silt-laden current can pass, though with greatly diminished velocity, the velocity being so reduced just below the dike as to cause, generally, immediate, rapid, and heavy deposits of silt. These deposits are generally soon overgrown with willows or cottonwood, and after they arrive at sufficient height they can be revetted on their river fronts.

To guard against loss by scour of the piles a broad, flexible mattress is first sunk on the line of the hurdle; through this mat the piles and clumps of piles are driven.

During the past year the hurdles have been constructed of clumps of piles, three piles and upward to each clump. These piles are driven so that when their upper ends are drawn together by means of a wire rope they form a sort of pyramidal structure, the horizontal distances of the piles from each other at the surface of the river bed being 8 to 10 feet, depending mainly upon the depth of the water.

The wire ropes are made on the work; they are composed of 14 to 18 strands of No. 14 galvanized iron wire. They are drawn taut by means of the pile-driver machinery. At each turn of the rope round the upper end of the clump of piles a spike is driven as an additional guard against the rope slipping, though the wire itself binds or cuts into the piling sufficiently to prevent any slip. This method of drawing the upper ends of the piles together appears to be better than the old one of bolting them.

The tops of the piles are generally at an elevation of 20 feet above extreme low water, excepting that, in the curtain or wattling row, the top of one pile of the clump is at an elevation of about 25 feet above that stage in order to intercept drift at high stages and prevent it from crossing the line of hurdle and dragging the top of the latter with it.

The curtain or wattled row is strengthened by vertical diagonal braces heeled against a row of clumps spaced at such distance below as to make the angle of the braces about 45 degrees.

The heel of the brace is held by a clevis passing around one of the piles of the lower clump with its pin through the brace. At top the brace is bolted to one or more of the piles in the upper clump.

The piling of the hurdle row is so spaced as to represent an equivalent of one pile to the linear foot of hurdle. The piles are driven by means of the hydraulic jet as well as by the hammer, the latter weighing 2,400 pounds, and sometimes by both combined.

The completed curtain or the wattling, whichever may be used, is generally carried finally to a height of 20 feet above extreme low water. The mattress is from 60 to 135 feet in width, depending upon the depth of water and consequent length of piles, as well as upon liability of the bed to suffer from scour. It is fabricated upon floating ways, in place, by wattling brush upon poles spaced about 5 feet apart and in any length desired. Continuity is obtained by lapping the poles and fastening them together with spikes and wire. When additional strength is required, wire cables are used across and in the direction of the length of the mattress. The brush is spiked to the poles at the edges of the mattress and at other points, about one spike to every third rod of brush. In sinking the mat a little less than 1 cubic yard of rock is required to a cord of brush.

The piles used in the hurdles run in lengths from 25 to 60 feet, and

their average penetration in the bottom is about 15 feet. They are driven with the large end down.

At the shore end of the hurdle the bank is revetted for about 300 feet, of which 200 feet are below the axis of the hurdle.

In constructing the shore revetment a mat about 120 feet in width, its inner edge at the surface of standard low water, is sunk. The bank is then eventually graded to a slope of one-half and covered with rip-rap. Where necessary to grade the bank by artificial means the grading is done by the hydraulic method or by means of shovels, etc.

The foregoing is a general description of the work of construction during the past year.

At the beginning of the fiscal year the work for improvement had been extended to the head of Turkey Island, but the construction at a number of points had been left incomplete, especially as to number and extent of works, in order to observe the effect of the hurdles as built. A number of new banks, the result of deposits induced by hurdle work, required revetment to secure their permanency, notably at Horsetail, Twin Hollows, and Jim Smith's.

During the past fiscal year new work was prosecuted at a number of points and as far as Bruce Island, 40 miles below St. Louis, and extensions and repairs of work were also made as follows, the distances all being measured from the River Des Peres, the southerly limit of St. Louis:

HORSETAIL BAR, IMMEDIATELY BELOW ST. LOUIS.

At the beginning of the fiscal year a number of depressions in the accretions on the east side formed small channels at high stages of the river, and some erosion had occurred at the lower end of the reach. On the west side the bank protection needed extension.

The work of the fiscal year at this locality consisted in extending the west side protection 2,485 feet, to the lower end of the new bank, with the exception of a short piece below Dike No. 1, which could not be got at on account of the occupation of that piece by a steamer moored at the bank. The owner of the steamer was requested in writing to move her, but no answer was returned, and as cold weather shortly afterwards set in, this particular piece of revetment could not be undertaken.

The protection consisted of the usual revetment for 1,958 feet, to a stage of about 8 feet above standard low water, the rest of the distance being covered by construction and placing of a mat 130 feet wide, the upper edge of the mat on the bank being at the surface of the water at the stage prevailing during October and November, and which was about standard low water. This revetment is not complete.

On the east side a series of hurdles was projected to rebuild the bank which had been eroded, and to extend the contraction works so as to join those at Carrolls Island.

By the close of the year seven lines of hurdles had been built, aggregating 4,340 feet in length.

HEAD OF CARROLLS ISLAND TO JIM SMITH'S.

This reach of river is about 9 miles long, and embraces the localities known as Carrolls Island, Twin Hollows (east and west), Pulltight, Chesley Island, and Jim Smith's. Carrolls Island is about 4 miles below St. Louis.

During low-water season of 1892 (calendar year) the depth at Twin

Hollows was only 6 feet, and at Pulltight 4½ feet, at the stage of standard low water, and was less than the depth found on any other of the bars, where improvement had not been completed, between St. Louis and Fort Chartres.

Of the series of hurdles projected for the west side of Carrolls Island, four, of an aggregate length of 2,160 feet, were built.

At Twin Hollows, west, the repairs, extensions, and construction of hurdles which was in progress at the beginning of the fiscal year, was continued. Six hurdles, aggregating 2,410 feet in length, were built.

At Twin Hollows, east, the work of the year consisted in minor repairs and extensions of the revetment built in 1882 and years following. An aggregate of 9,420 square feet of revetment was placed.

At Pulltight the work which was in progress at the beginning of the fiscal year was continued in repairs, extension of the old hurdles, and building of others required toward completion of the improvement. Seven hurdles of an aggregate length of 6,645 feet were built, and one hurdle, previously built, was extended 750 feet.

To protect the river ends of hurdles 0 and 1 against moving ice buttresses of brush and stone were built, and extra clumps of piles were driven at the end of Hurdle 0¼ for the same purpose.

At Chesley Island the new bank formed by the hurdles behind the island was protected and the revetment at the head of the island was completed, and that on the east bank of the same was repaired in part.

No work was done at Jim Smith's during the year.

For more complete details of the work reference is made to the reports herewith of Messrs. D. M. Currie and Gerald Bagnall, assistant engineers; also to Pl. No. 2 herewith.

RUSH TOWER.

This reach, which extends from the head of Calico Island to Brickeys Mill, includes several detached works, viz, protection of the west side of Calico Island, hurdles on the east side near James Landing, hurdles on the west side below Kennetts Castle, bank protection from Osborne Field to Durfees Landing, hurdles below Durfees Landing, and works projected for regulating the river at Fish Bend when the natural changes now in process at that point shall have given an average width of about 2,500 feet to the channel (cut-off) through the chute.

Calico Island is about 22 miles below St. Louis. None of these works have been completed.

The work in this reach during the past fiscal year consisted in the repair of Hurdle No. 3 on the west side between Kennetts Castle and Perry Towhead, in which an equivalent of 400 feet of hurdle was built. The protection from Osborne Field to Durfees was extended 1,970 feet upstream by placing a mattress below standard low water and revetting the bank to a height of about 10 feet above that stage, and the revetment placed during the preceding year was also repaired and extended up the bank.

FORT CHARTRES.

This reach, extending from Brickeys Mill to the head of Turkey Island, which is 43 miles below St. Louis, includes a dam of brush and stone at Bruce Island, and which was partly built in 1875, the protection of the left bank below Sycamore Landing, and a series of hurdles to close the chute west of Bruce Island (formerly Fort Chartres Towhead), upon

work was begun in 1892, at which time the left bank of the river te Bruce Island was protected below medium stage of water for ıuce of 5,500 feet downstream from Sycamore Landing, and Hur-. 2, located on the site of the dam partly built in 1875, and Hur-o. 3, 1,000 feet below No. 2, were built. These hurdles were repaired in the spring of 1893, they having been considerably ged by ice upon the break-up of the river about the latter part of ary of that year.

work of the past fiscal year in this reach was as follows:

dle No. 2, of the Bruce Island series, was further repaired. The of hurdles was extended to the head of the bar above the island ilding six new hurdles of a total length of 9,375 feet.

protection on the left bank of the river, oposite Bruce Island, xtended up the bank to an elevation of about 22 feet above ard low water for a distance of 3,750 feet from its upper end.

more complete details of the work reference is made to the reports, ith, of Messrs. D. M. Currie and W. S. Mitchell, assistant engi-

Also to Pl. No. 3, herewith.

total of construction work done during the year is as follows:

	Linear feet.
built	25,520
repaired	1,400
rotection (revetment) built complete	632
rotection (revetment) partly built, including extensions and repairs	21,235

of the work was done by hired labor.

MATERIAL USED.

following quantities of piles, brush (for matresses), and rock were n the works during the year:

	linear feet..	829,372
n place	cords..	31,702.19
ı place	cubic yards..	83,872.33

UTILIZATION OF DRIFT.

high stages of the river immense quantities of drift are carried stream by the flood. A great deal of this drift lodges against the es and sometimes in quantities sufficient to menace their stability through static pressure or by producing scour about the piling.

e fields of drift thus formed can be sunk in place just above the es they form excellent, permeable dams, often of considerable t, and also serve as protection to the hurdles against which they rested; but in general the drift must be sunk quickly, otherwise, ially at very high stages of water, it may become dangerous to urdles as noted above.

e fields of drift are sunk by laying on top of them, rapidly and as y as possible, a sort of mattress of brush and then weighting the e with stone.

good deal of drift was utilized in this way during the year.

PROCURING MATERIALS.

e brush used was procured by hired labor. Of the stone used 6.30 cubic yards were procured by hired labor at the United States y at Little Rock, Mo., a short distance above Ste. Genevieve, and

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also on a scale of 1:25000, shows the river from Forrest Home to Fort Chartres. Pl. No. 4, a profile, shows surface slopes at flood, high, and low stages of the river. This profile is from gauge readings as explained on the plate. In 1892, eight gauges were established from Jefferson Barracks to Jones Point in order to determine, if possible, whether any change in slope of water surface results from the works for regulation of the river channel.

These gauge observations have not been continued long enough to enable the extent of changes in surface slopes to be determined, but they indicate that the water surface has been lowered at all stages wherever the bars have been removed.

VALUE OF PROPERTY.

The present value of property belonging to this work is shown in the following table:

Class of property.	Value July 1, 1893.	Purchases, additions, and repairs.	Expenses and deterioration charged to works of improvement.	Value June 30, 1894.
Steamer Gen. Gillmore	$10,871.98	$25,650.11	$22,810.20	$13,711.89
Steamer Gen. T. L. Casey	.....	36,346.97	11,421.27	24,925.70
Steam launches (2)	4,582.37	2,039.03	6,621.40	.....
Steam tenders (3)	10,060.38	12,649.92	2,383.39	20,326.91
Barges, model (49)	76,684.51	80,475.89	18,462.59	138,697.81
Barges, quarter (11)	17,166.81	4,957.98	5,948.16	16,176.63
Quarter boats (10)	1,733.33	51,996.81	2,625.55	51,104.59
Office and survey boats (3)	.....	13,686.50	1,360.50	12,326.00
Pile drivers (34)	31,533.55	102,097.35	15,052.15	118,578.75
Derrick boats (2)	1,500.00	4,212.90	839.25	4,873.65
Derrick	.....	1,011.50	.....	1,011.50
Small boats (165)	12,269.99	69,498.95	20,192.97	61,575.97
Portable quarters	7,051.18	2,634.03	3,783.00	5,902.21
Tents	190.75	.....	190.75	.....
Supply depot	3,105.50	3,564.04	2,389.29	4,280.25
Ways (supply depot)	.....	4,421.27	836.29	3,584.98
Machine shop	1,943.60	437.03	790.56	1,590.07
Tools and appliances	6,734.79	12,685.49	6,076.36	13,343.92
Boarding outfit	11,896.96	19,132.33	5,655.26	25,374.03
Office furniture	451.27	175.50	93.29	533.48
Survey instruments	634.08	1,387.40	111.22	1,910.26
Photographic apparatus	257.14	.....	.....	257.14
Total	198,668.19	449,061.00	127,643.45	520,085.74

CONDITION OF THE RIVER.

The stages of water ranged from extreme low to standard low water (4 feet above extreme low) from the middle of September to the latter part of February. The gauge registered extreme low water on the 9th of December, 1893. During a part of this time depths of 4½ feet were found at Sulphur Springs and Fort Chartres crossings, both within the reach under improvement but the works for which were incomplete. The indications are that increased depth will hereafter be found at the Fort Chartres crossing (Bruce Island). Further work will probably be required at Sulphur Springs crossing.

At Pulltight, where 4½ feet depth existed during the low-water season of the year 1892, no depth less than 8 feet was found during the navigation periods of the past fiscal year.

STATISTICS.

Attention is respectfully invited to the tables of statistics of the commerce of the river hereto appended. These, as well as the statistics for the other works of improvement reported upon were compiled by Mr. Elliott Jones, chief clerk.

HISTORICAL SKETCH OF THE WORKS.

The report of Mr. D. M. Currie, assistant engineer, already referred to, contains an interesting résumé of the different methods of construction pursued at times upon the works since 1872.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1896, is $758,333.33, which is the sum estimated in the last annual report for the fiscal year ending June 30, 1895. It is proposed to expend this sum in carrying out the programme heretofore adopted; that is, to carry on the work of improvement continuously from St. Louis downstream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed to obtain by this means a channel of at least 8 feet at low water. The depth is now liable to become as small as 4 feet or even less in some places, and less at every locality where the width is more than 2,500 feet.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this improvement of the river between the mouth of the Ohio and the mouth of the Missouri River, as revised in 1883, is $16,397,500.

The aggregate amount from appropriations available for this work to June 30, 1893, is $5,388,333.33, and as follows:

APPROPRIATIONS.

By act of—		By act of—	
June 10, 1872	$100,000.00	August 2, 1882	$600,000.0
March 3, 1873	200,000.00	July 5, 1884	520,000.0
June 23, 1874	200,000.00	August 5, 1886	375,000.0
March 3, 1875	200,000.00	August 11, 1888	300,000.0
August 14, 1876	200,000.00	September 19, 1890	400,000.0
June 18, 1878	240,000.00	July 13, 1892	525,000.0
March 3, 1879	200,000.00	March 3, 1893	658,333.3
June 14, 1880	250,000.00		
March 3, 1881	600,000.00	Total	5,568,333.3

Of these amounts, $180,000 were allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving amount applicable for general improvement between the mouth of the Ohio and Missouri rivers $5,388,333.33.

Amount expended to include June 30, 1893, $4,364,570.32.

Amount expended during the fiscal year ending June 30, 1894, $825,919.86.

The balance available, $60,515.22, will be expended in prosecuting work according to the approved project. Funds having become low

he expenses were considerably reduced in June, and it is proposed, on ccount of the necessity of having some funds available to meet contingencies and also to enable the plant to be cared for, to keep a reasonble reserve of funds until a new appropriation shall be made.

Recurring to the expenditures to include June 30, 1893, and to the xpenditure for the past fiscal year, it must be said—although the mprovement is far from being completed, in fact, being but little more han fairly begun—that the river between the mouths of the Ohio and Missouri is much better for navigation than it was before the work of mprovement began, and that the difficulties and dangers to navigation re much less than they were twenty years ago. In giving credit to he work for improvement of the river, the operations of the snag boat n freeing the river of snags must not be overlooked.

Money statement.

ly 1, 1893, balance unexpended		$1,023,763.01
ne 30, 1894, amount expended during fiscal year		825,919.86
ly 1, 1894, balance unexpended		197,843.15
ly 1, 1894, outstanding liabilities	$28,459.12	
ly 1, 1894, amount covered by uncompleted contracts	69,022.07	
		97,481.19
ly 1, 1894, balance available		* 100,361.96
Amount (estimated) required for completion of existing project		11,009,166.67
Amount that can be profitably expended in fiscal year ending June 30, 1896		758,333.33

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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etract of proposals received in response to advertisement dated June 16, 1893, and opened July 17, 1893, by Maj. Chas. J. Allen, Corps of Engineers, St. Louis, Mo., for furnishing 3 steam tenders, 4 quarters boats, 1 office and survey boat, 12 barges, 11 pile-drivers, 100 flats, 30 skiffs, and 10 yawls.

mount available	$843,000
mount of awards	152,505

	Name and address of bidder.	One large steam tender.	Two small steam tenders.		Four quarter boats.			One office and survey boat.
			Price for each.	Amount.	Number proposed to be furnished.	Price for each.	Amount.	
2	Ed. J. Howard, Jeffersonville, Ind	$7,425.00	$4,425.00	$8,850.00	4	$5,390.00	$21,560.00	$4,770.00
3	M. A. Sweeney Co., Jeffersonville, Ind	6,990.00	4,400.00	8,800.00	4	5,498.00	21,992.00	4,340.00
5	The Davis Boat and Oar Co., Detroit, Mich	10,900.00	7,400.00	14,800.00	4	8,950.00	35,800.00	8,400.00
9	Samuel W. Skinner, Wilmington, N. C				4	5,964.30	23,857.20	
12	Geo. T. Nelles, Leavenworth, Kans				4	6,170.00	24,680.00	4,500.00

* Of this amount but $60,515.22 is at present available for the works now in progss, $39,846.74 being allotted for special work at Ste. Genevieve, Cape Girardeau, nd Cairo.

Abstract of proposals received in response to advertisement dated June 16, 1893, and opened July 17, 1893, by Maj. Chas. J. Allen, etc.—Continued.

No.	Name and address of bidder.	Twelve barges.			Eleven pile-drivers.		
		Number proposed to be furnished.	Price for each.	Amount.	Number proposed to be furnished.	Price for each.	Amount.
1	David S. Barmore, Madison, Ind.....	6	$3,590.00	$21,540.00	.....	.....	.....
2	Ed. J. Howard, Jeffersonville, Ind ...	6	3,650.00	21,900.00	11	$4,150.00	$45,650.00
3	M. A. Sweeney Co., Jeffersonville, Ind.	6	3,990.00	23,940.00	11	4,248.00	46,728.00
5	The Davis Boat and Oar Co., Detroit, Mich	12	6,350.00	76,200.00	12	6,495.00	77,940.00
9	Sanford S. Holbrook, Cincinnati, Ohio.....	6	4,400.00	26,400.00	.....	.....	.....
10	Samuel W. Skinner, Wilmington, N.C.	.....	.....	.....	11	4,188.40	46,072.40
11	Clements Bros., Paducah, Ky.....	12	3,950.00	47,400.00	.....	.....	.....
12	Geo. T. Nelles, Leavenworth, Kans ..	.....	.....	.....	11	3,590.00	39,490.00
14	J. N. Wright and H. S. Brown, Quincy, Ill	.....	.....	.....	11	4,445.00	48,895.00

No.	Name and address of bidder.	One hundred flats.			Thirty skiffs.		Ten yawls.	
		Number proposed to be furnished.	Price for each.	Amount.	Price for each.	Amount.	Price for each.	Amount.
1	David S. Barmore, Madison, Ind .	100	$426.64	$42,664.00	.....	.....	.....	.....
2	Ed. J. Howard, Jeffersonville, Ind.....	.....	.....	.....	$60.00	$1,800.00	$120.00	$1,200.00
4	T. G. Isherwood, Davenport, Iowa	100	263.00	26,300.00	.....	.....	.....	.....
5	The Davis Boat and Oar Co., Detroit. Mich.....	100	948.50	94,850.00	29.50	885.00	70.00	700.00
6	Wm. Schlecht, Cincinnati, Ohio ..	.....	.....	.....	36.00	1,080.00	125.00	1,250.00
7	R. C. Arnold, Leavenworth, Ind..	50	284.50	14,225.00	.....	.....	.....	.....
8	Robt. G. Brown, Quincy, Ill.....	.....	.....	.....	40.00	1,200.00	100.00	1,000.00
10	Samuel W. Skinner, Wilmington, N. C	100	314.45	31,445.00	.....	.....	.....	.....
12	Geo. T. Nelles, Leavenworth, Kans	100	317.00	31,700.00	.....	.....	.....	.....
13	Wiegel Bros. & Co., Elizabeth, Pa.	100	425.00	42,500.00	.....	.....	.....	.....
15	Kahlke & Bro., Rock Island, Ill .	25	427.50	10,687.50	.....	.....	.....	.....
16	The Truscott Boat Manufacturing Co., St. Joseph, Mich.....	.....	.....	.....	34.75	1,042.50	96.00	960.00
17	Geo. W. McAdams, Columbia, Ohio.....	.....	.....	.....	36.00	1,080.00	120.00	1,200.00
18	Thos. Drien & Son, Wilmington, Del	.....	.....	.....	90.00	2,700.00	125.00	1,250.00
19	Jas. P. Simms, St. Louis, Mo	.....	.....	.....	33.00	990.00	90.00	900.00

No. 1.—Guarantee not dated.
No. 2.—Proviso attached in regard to skiffs.
No. 5.—Bids on 12 pile-drivers instead of 11, the number required.
No. 6.—Proposal not dated and no guarantee attached.
No. 8.—Guarantee not dated.
No. 11.—Guarantee not dated.
No. 13.—Price given is for flats delivered at Cairo, Ill. Telegram accompanying adds $23 to price of each flat delivered at St. Louis, Mo.
No. 14.—Provides for delivery of pile-drivers in Quincy Bay, Ill. Letter and blue prints accompanying No. 14.
No. 15.—Signatures of guarantors not witnessed. Justification of guarantors not executed.
No. 17.—One copy of proposal only received. Specifications not attached and no guarantee given.
No. 18.—One copy only of proposal received. Specification not attached and no guarantee given. Accompanied by letter qualifying bid.
No. 19—No guarantee given. In price for skiffs words and figures do not agree. Certificate of justification of guarantors signed by notary public.

AWARDS.

Proposal No. 1.—David S. Barmore, Madison, Ind.:
6 barges, at $3,590 each $21,540
Proposal No. 2.—Ed. J. Howard, Jeffersonville, Ind.:
4 quarter boats, at $5,390 each 21,560
6 barges, at $3,650 each 21,900

Proposal No. 3.—M. A. Sweeney Co., Jeffersonville, Ind.:	
1 large steam tender, at $6,990	$6,990
2 small steam tenders, at $4,400 each	8,800
1 office and survey boat, at $4,340	4,340
Proposal No. 4.—T. G. Isherwood, Davenport, Iowa:	
100 flats, at $263 each	26,300
Proposal No. 5.—The Davis Boat and Oar Co., Detroit, Mich.:	
30 skiffs, at $29.50 each	885
10 yawls, at $70 each	700
Proposal No. 12.—George T. Nelles, Leavenworth, Kans.:	
11 pile-drivers, at $3,590 each	39,490

Abstract of proposals received in response to advertisement dated November 11, 1893, and opened December 11, 1893, by Maj. Charles J. Allen, Corps of Engineers, St. Louis, Mo., for furnishing piles.

Amount available from appropriation of March 3, 1893, for improving Mississippi River, between mouths of Ohio and Missouri rivers $460,000.00
Amount of award 82,162.69

No.	Name and address of bidder.	25 to 30 feet long.		31 to 35 feet long.		36 to 40 feet long.	
		No.	Price per foot.	No.	Price per foot.	No.	Price per foot.
1	St. Louis Refrigerator and Wooden Gutter Co., St. Louis, Mo	1,500	*Cents.* 6.725	6,500	*Cents.* 6.725	8,000	*Cents.* 6.725
2	Huse & Loomis Ice and Transportation Co., St. Louis, Mo	1,500	6¾	6,500	6¾	8,000	6¾
3	Sterling Fort, Memphis, Tenn	1,500	5.99	6,500	6.24	8,000	6.49
4	Charles Gaertner, St. Louis, Mo	1,500	6¾	6,500	6¾	8,000	7
5	John Cleary, Chester, Ill	1,500	5¾	6,500	5¾		
6	Whitney Gilbreath, Ava, Ill	500	6¾	2,233	6¾	2,334	6¾

No.	Name and address of bidder.	41 to 45 feet long.		46 to 50 feet long.		51 to 60 feet long.		Amount.
		No.	Price per foot.	No.	Price per foot.	No.	Price per foot.	
1	St. Louis Refrigerator and Wooden Gutter Co., St. Louis, Mo	6,500	*Cents.* 6.725	4,500	*Cents.* 6.725	3,000	*Cents.* 6.725	$82,162.69
2	Huse & Loomis Ice and Transportation Co., St. Louis, Mo	6,500	6¾	4,500	6¾	3,000	6¾	83,995.31
3	Sterling Fort, Memphis, Tenn	6,500	6.74	4,500	7	3,000	7.74	82,430.67
4	Charles Gaertner, St. Louis, Mo	6,500	7	4,500	7	3,000	7	84,883.13
5	John Cleary, Chester, Ill							14,805.62
6	Whitney Gilbreath, Ava, Ill	2,233	6¾	1,500	6¾	1,000	6¾	26,976.37

No. 1.—Lowest; acceptance recommended.
No. 5.—Incomplete; a portion of each size not being bid upon, as required by specification 36.
No. 6.—Less than one-third bid upon. If total number were bid upon at rate here given, the total bid would amount to $82,468.12.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., June 30, 1894.

MAJOR: I have the honor respectfully to submit the following report upon the improvement of the Mississippi River between the Ohio and Missouri rivers for the fiscal year ending June 30, 1894, including as part of it the accompanying reports of assistants in local charge.

The general improvement of the Mississippi River between the Ohio and Missouri rivers has been prosecuted for the purpose of obtaining at standard low-water depths not less than 6 feet above and 8 feet below the city of St. Louis, the depths being no more than 3½ feet at many points in the natural state of the river.

Improvements have been made at several points in local interests, in compliance with special appropriations and mandatory provisions of river and harbor acts supplemented by allotments from the general funds.

Referring to dates by fiscal years, the work was begun in 1873 and prosecuted at several detached localities through the following years, to include 1880, upon a plan which contemplated confining the river at low stages to a single stream having a

The work consisted of a foot wall of brush and stone placed in a trench ex throughout its entire length for low-water protection, and of revetment from the top of the bank to a distance of 1,118 feet above Grand avenue, while cro at intervals of about 120 feet, extending from the top of the bank to the fo completed the protection on the remainder of the distance.

This protection has been damaged to a certain extent by driftwood and ice, but still prevents erosion of the bank.

Venice Bend.—Four dikes in Venice Bend were designed and partly built authorities to improve St. Louis Harbor. As found in 1872, the upper or B Dike was 1,390 feet long, the others 120, 387, and1, 360 feet, respectively. T known as "Long Dike," was raised to about 14 feet above low water and e 600 feet in accordance with the recommendations of a board of engineers c February, 1872.

Prior to the beginning of the general improvement in 1872, appropriations improvement of St. Louis Harbor had been made as far back as 1836, and t tudinal dike was built from Kerrs Island to Bloody Island, with cross dikes c ing it with the Illinois shore. In 1891 and 1892 a series of 12 hurdles was Venice Bend, which lies between Eads Bridge and Bissells Point, under the for the expenditure of the appropriation of $182,000, for the improvemen Louis Harbor, by the river and harbor act approved September 19, 1890. T ect consisted in contracting the river to about 2,000 feet average width, to middle bars, and improve landings.

This work has been very successful; the middle bars have been removed to extent, and the landings have been improved.

No work has been done since 1892.

Cahokia Chute and Arsenal Island.—Cahokia Chute was closed first by a st built to the stage of 5 feet above standard low water prior to the adoption permeable system, and afterwards by hurdles to the stage of 16 feet above t plane. At higher stages a small stream of water still finds an outlet thro chute, and has eroded the bank near the head of Arsenal Island.

In connection with the closing of the chute, the west face of the island w tected to the top of the bank near its head, but on the lower part only to the stage, or about 15 feet above low water. This medium stage protection h damaged by the erosion of the bank during higher stages of several years, bu during the long flood stage of 1892.

No work was done at this locality during the year just closed.

The works from Sawyer Bend to Arsenal Island, inclusive, are within th of St. Louis Harbor.

Horsetail Bar.—At this locality extending from the River Des Peres to the Carrolls Island a series of 5 dikes, one on the west side, the others on t side, with a training wall connecting the ends of those on the east side to the width and consolidate the river into a single stream about 2,400 feet wi projected in 1873 and constructed during that and the years following to 1880

ke No. 1, by placing a mattress 130 feet wide below the surface of the water at the age prevailing during October and November, which was about standard low water. The bank was revetted to about 8 feet above standard low water upon a distance 1,958 feet, located as shown on the accompanying sketch, Pl. No. 2.

On the east side a series of hurdles was projected to reestablish the bank which ad been eroded and to extend the contraction down to Carrolls Island. At the lose of the year 7 lines had been built, Nos. 20½, 220 feet long; 22½, 750 feet long; 4½, 670 feet long; 27½, 950 feet long; 29½, 880 feet long; 30½, 670 feet long, and 31½ 20 feet long.

See Pl. No. 2 and the report of Mr. Gerald Bagnall, assistant engineer, for further details.

Head of Carrolls Island to Jim Smith's.—Formerly divided for purposes of administration into Carrolls Island, Twin Hollows, east and west, Beards Island, Chesley Island, and Jim Smith's.

The work in this reach was begun during the year 1882 upon a project of which the present one is a continuation and which included a series of works on the west side extending down to the foot of Fines Bluff, the protection of the bank on the east side from the foot of Carrolls Island to Pulltight Landing, afterwards known as Pulltight; a series of hurdles from that point, to include one behind Beards Island, followed downstream by the protection of the west bank of Beard's Island; hurdles at Jim Smith's; hurdles at Chesley Island to close the Meramec Chute, and protection of the bank on the head and channel side of the island. During that and succeeding years, to include the year 1884, the bank protection below medium stages and hurdles on the east side were completed, the series of hurdles on the west side was extended down to include No. 4, as shown on Pl. No. 2, when on account of a persistent effort of the channel to make a crossing to the west bank at a point near the mouth of White House Creek, the project was revised in 1888, and the Pulltight hurdles, Nos. 1, 2, and 4 were extended, and No. 5 was built, when work was again suspended to await developments. During low-water seasons the depth has been very small in the channel crossing to the west bank near White House Creek, while hurdles Nos. 1, 2, 4, and 5, Pulltight, were seriously damaged by ice, driftwood, and floods, and further work was projected during the year 1893, having for its object the reduction of the reach from the head of Carrolls Island to Jim Smith's to an average width of 2,500 feet to secure a minimum depth of not less than 8 feet at standard low water. This included hurdles on the west side of Carrolls Island, the protection of new bank, repairs to hurdles Nos. 2 to 5, inclusive, and the construction of additional hurdles at Twin Hollows, and the repairs and extension of hurdles Nos. 1 to 5, inclusive, and the construction of No. 6 at Pulltight. (For the location and extent of all these, reference is made to Pl. No. 2.)

During the low-water season of 1893 the depth at Twin Hollows was only 6 feet, and at Pulltight 4½ feet, and was less than that found on any other bars within the reach from St. Louis to Fort Chartres, which had been partly improved.

CARROLLS ISLAND.

Of the series projected on the west side of Carrolls Island, four hurdles, Nos. 2, 800 feet long; 3, 570 feet long; 4, 450 feet long; and 5, 340 feet long, were built this year. (See Pl. No. 2 and the report of Mr. Bagnall for further details.)

Twin Hollows, west.—The repairs, extensions, and construction of hurdles which were in progress at the beginning of this year were continued, and Nos. 2½, 240 feet long; 3, 450 feet long; 3½, 710 feet long; 4, 520 feet long; 4½, 330 feet long; 6, 160 feet long, were built. The protection of the new bank, which was begun in 1886, when a low-water mattress was placed to a distance of 2,633 feet with revetment to the top of bank to a distance of 900 feet, both measured from its upper end and repaired in 1888, was during this year extended 2,180 feet farther downstream and the old revetment repaired to a distance of 750 feet from its lower end. (See Pl. No. 2, and the report of Mr. Bagnall for further details.)

Twin Hollows, east.—Such minor repairs and extensions to higher stages, as were urgently needed, were made to the revetment placed in 1882 and succeeding years, in aggregate 9,420 square feet were placed. (See Pl. No. 2 and the report of Mr. Bagnall for further details.)

Pulltight.—The work in progess at the close of last year was continued upon repairs, extension of the old hurdles and the construction of others projected to complete the improvement. Hurdles Nos. 0, 550 feet long; 0½, 1,060 feet long; 0½, 1,400 feet long; 1, 550 feet long; 6, 650 feet long; 7, 1,200 feet long, and 8, 1,235 feet long were built, and 750 feet in length of No. 1, was repaired. To protect the river ends of the hurdles, buttresses of brush and stone were built on Nos. 0 and 1 and extra clumps of piles were driven on No. 0½. (For further details see Pl. No. 2 and the report of Mr. Bagnall.)

portion on the west side could be built the channel changed and crossed west bank below the foot of Chesley Island instead of to Waters Point, and a revised project hurdles on the east side were extended to reduce the river average width of 2,500 feet.

At high stages a small channel remains open through the hurdles near their e ends, and the channel returned to Waters Point during this year.

A short section of the bank between hurdles Nos. 0 and 1, has been protecte

No work was done during this year.

Sulphur Springs.—The work in this locality was begun in 1887 and a series dles was built extending from the foot of Jim Smith's to the head of Fosters I Some of the hurdles have been seriously damaged by ice, driftwood, and flood several small streams remain open through them at high stages.

No work has been done during this year.

Fosters Island.—The protection to the medium stage of the west bank of I Island was placed during the years 1882 and 1884 and has been damaged erosion of the bank above during the flood stages, notably during that of 189

No work was done during this year.

Lucas.—The construction of hurdles in this reach, which extends from the Fosters Island to the head of Calico Island, was begun in 1888 and continued close of the year ending June 30, 1890. Hurdles were built, as shown on Pl and the construction of others was deferred to await developments. The upp has been seriously damaged by ice, driftwood, and floods; others have sustaine injuries.

No work was done during this year.

Rush Tower.—In this reach, which extends from the head of Calico Isl Brickey's Mill, are included several detached works, the protection of the we of Calico Island, hurdles on the east side near James Landing, hurdles on th side below Kennett's Castle, bank protection from Osborne Field to Durfees ing, and hurdles below Durfee's, upon which works have been prosecuted und projects for the expenditure of appropriations approved September 19, 189 13, 1892, March 3, 1893, and other works were indicated in outline in the chu ting off Fish Bend when developments shall have reached a stage which wi average width of 2,500 feet to the channel through the chute.

None of these works have been completed.

During this year Hurdle No. 3, on the west side, below Kennetts Castl repaired, in which an equivalent of 400 feet of hurdle was built. The prot from Osborne Field to Durfees was extended 1,970 feet upstream by placing tress below standard low water and revetment to about 10 feet above that high as the bank had a grade suitable to receive, and the revetment placed the preceding year was repaired and extended as required. (For further reference is made to Pl. No. 3 and to the accompanying report of Mr. Will Mitchell, assistant engineer.)

Fort Chartres.—This locality, extending from Brickeys Mill to the head of T

Turkey Island.—A dam of brush and stone was begun during the spring of 1875 d was partly built during that and the years 1876 and 1877. When work was sus- nded, the chute was closed at stages below 3 feet above standard low water. No ork has been done since October, 1876, and no water passes through the chute at w and medium stages of the river.

Ste. Genevieve.—The project for the improvement of this locality was adopted in 890, and consisted in the construction of a series of hurdles on the Illinois side of he river, designed in accordance with the requirements of the river and harbor act pproved September 19, 1890, to prevent the channel leaving Little Rock, the land- ing for Ste. Genevieve, and to contract the river to a width of 2,500 feet, and to be incorporated in and form part of the general improvement of the river when the work shall be extended to the locality in its progress continuously downstream in accordance with the plan adopted in 1881.

The series contemplated four hurdles, but the bar below Turkey Island had moved downstream, so that the upper one was not necessary. The work was begun in May, 1891, and the other three hurdles were completed the July following, and during the spring of 1892 minor repairs were made.

No further work has been done and the channel remains at Little Rock.

Kaskaskia Bend.—A project for the protection of this bend was adopted in 1876 and modified in 1880 to stop the caving in of the bend, which was 23,000 feet long.

The work was continued as funds were available until 1881. After direct revet- ment had been applied to about 6,000 feet of bank and a hurdle 1,140 feet long had been built to deflect the current away from the bank, the work was almost wholly destroyed by ice and flood. The flood, pouring into the Kaskaskia River through a depression in the bank with a fall of 6 feet, opened the way for a deep but narrow stream, which has since become the navigable channel.

No work has been done since 1881.

Liberty Island.—The original project at this locality contemplated closing the chute on the Missouri side of Liberty Island to concentrate the water in the channel, which had passed at low stages for a number of years by the village of Rockwood, Ill., opposite the island.

Work on the project was begun in July, 1875, but after the high water of August of that year the channel was found on the west side, while that via Rockwood was nearly closed, and the project was changed and the Missouri bank was revetted with stone, from 1876 to 1879, to a distance of 7,325 feet above the site of the projected dam.

No work has been done since 1879. The downstream end of this revetment remains in serviceable condition, but has been seriously damaged by caving of the bank from above.

Devils Island.—Work was begun at this locality during the fiscal year 1875 in accordance with a project which contemplated the closing of the Illinois and Pica- yune chutes by dams, and further contraction to the desired width by a dike from the west side of Devils Island.

The work was begun during the year 1875 when the low-water channel was in the Illinois chute, though the larger body of water flowed on the west side. The work was prosecuted as funds were available until 1877, when it was practically com- pleted.

The channel has been very much improved.

Cape Girardeau and Minton Point.—During the year 1881 a project was prepared and adopted to remove a bar in front of Cape Girardeau Landing and to secure not less than 8 feet at low water between the landing and Minton Point, Illinois, in accordance with requirements of special appropriations by the river and harbor acts of June 14, 1880, and March 3, 1881, and for the general improvement of the river from the Illinois to Ohio rivers.

A hurdle was built to a distance of 2,256 feet from the foot of Devils Island down- stream, making a considerable angle with the current, and a series of five cross hurdles at intervals of 400 feet was projected and partly built, connecting with the bar below Devils Island. Of the 5,329 feet thus projected 2,100 feet was practi- cally completed. Another hurdle inclined to the current was built from the Illinois shore near Wahoo Landing to distance of 3,100 feet. These were repaired after the high water of 1882, and the object for which the work was designed was obtained in part. The bar was removed and the desired depth secured, but to render the result permanent would require extension of the hurdles.

No further work has been done.

An appropriation of $22,500 was made by river and harbor act of 1884, but remains unexpended, waiting further appropriations.

Cairo protection.—Between 1858 and 1868 the Cairo Land Company built a series of spur dikes at Eliza Point, in rear of Cairo, Ill., to check the erosion of the bank. Two dikes at the upper end of the series had been undermined by the current and had disappeared when the protection was begun by the United States in 1877, in

expend the balance which remains available and located there by the ac
the appropriation.

Procuring materials.—The full quantity of brush used was procured by hi
The stone was procured in part by hired labor and the balance by purcha
market. The pile timber was procured in part by contract and the rem
purchase in open market.

Other material, including rope, bolts, wire, spikes, nails, and miscellan
plies, was procured in open market.

Plant.—At the beginning of the year the plant available and that pro
during the year 1893 was insufficient for prosecuting the work on a scale t
expend the available funds within this year, and further additions were
for by contracts entered into last summer, by purchase in open market, and
ing by hired labor with materials purchased in open market. The contracts
for 3 steam tenders, 12 model barges, 4 quarter boats, 11 pile-drivers (co
office and survey boat, 100 flats, 10 yawls and 30 skiffs, all to have been deli
later than April 1, 1894. Twenty-six flats were built after receiving se
posals on ten days' notice in open market. One floating derrick was pr
hired labor, with materials purchased in open market, using for that pu
hull and boiler of an old pile-driver; and 2 derricks at quarry are in p
erection by hired labor and purchase of material in open market.

Of the additions provided for during the years 1892 and 1893 all have
cured except 2 tenders and 1 office and survey boat, but 4 of the quarter b
not been outfitted and 9 pile-driver hulls and cabins still need their mach
up to complete them as pile-drivers.

The towboat *Gen. Gillmore* was taken out on the ways at Mound City
thoroughly overhauled, and the *Gen. Casey* was taken out on the marine w
city for small alterations. All other repairs to the plant have been made
at the yard connected with the supply depot.

Reference is made to the report of Mr. Lamb, superintendent of sup
further details of repairs made at the supply depot.

Plates.—Plate No. 1 is a general map of the river from the mouth of the
River to Chester, Ill., from the annual low-water survey made last fall
Merchants bridge, St. Louis; and above that point from the latest availa
and sketches recently taken in St. Louis Harbor above Sawyer Bend. Pl
3 show the river from the southern limits of the city of St. Louis to foot o
Island, and from Fort Forest Home to Fort Chartres Landing, respectively,
ties at which work has been done during this year. Plate 4 shows surf
at flood, high, and low stages from gauge readings, as explained thereon.

Gauges.—The eight gauges established in 1892 between Jefferson Bar
Jones Point, to determine whether any change in slope of the water surfa
from the improvement, were read daily, and their readings, together with s
authentic readings as were available, have been plotted. Surface slopes,
at flood stage and averages of high and low stages, are shown on Plate 4.

At Pulltight, where only 4½ feet was found during the low-water season of 1893, no depth less than 8 feet was found while navigation was open during this year.

Forms of construction.—During the latter half of the year a form of hurdle differing in some respects from any of those previously used was adopted for experimental tests. It consists (1) of a mattress to protect the bottom within the ordinary limits of scour above and below the line of hurdle. The width adopted for the mattress is about 100 feet, but is subject to increase or decrease as necessity may require. The mattress is placed from clumps, single piles, or other anchorages suitable to hold it during construction and sinking. (2) The piles in the hurdles are driven in clumps about 8 feet between centers, with elevation the same as in other forms, on a line passing centrally through and parallel to the direction of the mattress. The clumps consist of 3 to 7 piles, as may be necessary to resist the destructive forces to which the line may be exposed. The clumps are further strengthened where necessary by driving another line of piles or clumps below them and connecting the two lines by cross-stringers and diagonal braces heeled against the lower line. (3) A curtain is placed against the clumps in lieu of wattling. (4) The drift when collected in sufficient quantities above the upper line is sunk.

This form has not been sufficiently tested to fully determine its relative value, but the statement may be made that it possesses the elements of strength of the others and avoids some of their defects.

Other forms of contraction works used since 1872 have been tried experimentally also, and although they have proved successful in a greater or less degree, they have been changed from time to time in the effort to obtain the desired results at the least cost.

The two principal systems of contraction works which have been used, briefly described, are as follows:

1. Dikes and dams.—Solid stone dikes and dams were built in several localities from 1872 to 1879.

They were usually constructed on foundations of brush placed in layers alternately parallel to and across the current, and extending below the structure to protect the bottom against scour from overfall.

The dams at Cahokia Chute, Bruce, Turkey, Devils, and Picayune islands, the training walls and dikes at Horsetail Bar and a dike at Devils Island were built upon this system.

The results were satisfactory at first. The structures did not, however, build up new banks, and their continued success depended upon the obstruction that they offered to the flow of water without the channel limits, which in time created such disturbances, boils, whirls and eddies as to practically destroy their usefulness as works of improvement and they were abandoned. (See Report of the Chief of Engineers for 1880, p. 1362 *et. seq.*)

2. Hurdles.—This form of construction was adopted in 1879, at first in connection with the training wall which was retained as a solid structure, but built in cheaper form, wooden gates attached to a row of braced piles having been substituted for solid stone wherever in the line the depths were not too great for piles to be driven and made efficient by bracing; in greater depths, curtains, weeds and other light open structures were anchored by attaching one edge to a foundation mattress while afloat and then sinking the mattress, the other edge being held at the water surface by buoys. (See Report of the Chief of Engineers, 1880, p. 1362 *et. seq.*)

1. A hurdle at first consisted of a single row of piles driven 5 feet apart, with brush wattled upon them, pushed well down to the bottom and extending up to the stage of 15 feet above extreme low water, or, if the depths were excessive, a curtain was placed against the piles, instead of wattling, to retard the bottom current and prevent scour.

These hurdles were usually placed 300 feet apart, but the distance between lines was determined by currents, velocities, depths, etc. These gave results much more satisfactory than the solid dikes, though frail and often destroyed by ice on the breaking up of gorges in the spring and by drift accompanying floods. They induced heavy deposits of sediment within the space inclosed and formed a solid bank to concentrate the flow, at medium stages, in the channel.

Yet, from their frailty and small elevation, 15 feet above extreme low water, they did not completely reclaim the land and build to the height of the old banks within the time that they remained in efficient working condition.

2. In 1881 the hurdles were strengthened by driving the piles in two rows, braced in pairs and in clumps.

The upper end of the braces were framed into the piles and fastened to them by drift or screw bolts or wire strands.

The spaces between the hurdles were enlarged to compensate for the extra cost of strengthening, at first by gradually increasing the distance between them from the head of the series downstream until about 1,000 feet was reached. Afterwards

spaces were made experimentally 2,000 feet, but this distance having been found too great it was reduced to 1,000 feet.

A series of hurdles spaced at 1,000 feet, driven in clumps or braced rows, consumes about as many piles as one covering the same river frontage spaced at 300 feet between lines with piles driven in single rows.

The height of the hurdles remained about 15 feet above extreme low water, and a mattress was used to protect the bottom against scour when deemed necessary, but in working at high stages the piles were of necessity left above the water surface, which in one notable instance, Horsetail Bar, west, was at flood stage. The result was very satisfactory, a single flood being sufficient to complete the reclamation of the inclosed space nearly to the height of the natural bank. After this the height of hurdles was increased to 20 feet above extreme low water, and a foundation mattress to protect against scour became part of the usual form. Bracing was continued and stringers were added both in the direction of the hurdles and across it.

A third row of piles was also added, called the drift row, and intended to keep the heavy drift away from the hurdle or wattled row. (See sketch in Report of Chief of Engineers, 1885.)

This form was very strong, and seemed all that could be desired against horizontal static pressure, but, when sufficiently submerged, drift was carried over it and the hurdles, were seriously damaged, requiring extensive repairs after floods and after the breaking up of gorges accompanied by considerable rises. Also owing to the sequence of construction serious damages frequently occurred while the hurdles were incomplete; the piles being first driven, the mattress was built afloat around them and then sunk, thus leaving considerable portions of incomplete work exposed to the action of floods and drift. The driving of the drift row in clumps followed, at least one pile in each clump extending up to the 25-foot stage, the mattress was constructed ordinarily only on the lower side of the drift row with its upper edge attached to the lower piles of the clumps, but when currents parallel with the line indicated the necessity another mattress was placed above the clumps with its lower edge against them, and drift whenever accumulated in sufficient quantity above the piling was sunk. The stringers and tops of diagonal braces remained at the stage of 20 feet above extreme low water.

This form gave better results than any previously tried, but showed weakness during flood stages when the rising river brought large fields of drift under the braces and stringers and finally over the hurdles.

All these forms of hurdles gave satisfactory results in securing deposits and building up solid banks to concentrate the flow of water within the channel, but they also showed want of strength to resist the forces tending to destroy them.

The reports show that better results might have been attained, provided their serviceable life could have been lengthened; with that object in view hurdles with piles in single rows and anchored curtains and other light structures were replaced by braced hurdles with mattresses to protect the bottom, the elevation of the hurdles was increased from 15 to 20 feet above extreme low water and the distance between the hurdles was increased to compensate in part for extra cost (See Report of the Chief of Engineers, 1882, p. 1601.)

After experimenting with several forms of bracing and widths of mattress, the form shown in the report of the Chief of Engineers, 1885, was developed. (See p. 1655 *et seq.*, and plates of that report.)

In this the mattress was still built around the piles of the upper or drift row, which offered little resistance to heavy fields of drift during construction when floods carried fields of drift against or over it.

There was also evidence of destruction from buoyancy of ice and driftwood. Carrolls Island had a section about 1,000 feet long lifted out of place and carried away by ice in 1886. (See Report of Chief of Engineers, 1887, p. 1557.) Many hurdles showed the effect of the buoyancy of drift after the flood of 1892, which still may be seen at Lucas and other localities.

Scour, which has been the cause of considerable damage to hurdles, presents one of the most difficult problems connected with contraction works. It may be caused by currents parallel and in close proximity to the hurdles, by channeling under the mattress where it does not closely conform to the inequalities of the bed, by overfall or by rushing around the end of the obstruction. A wide mattress protects for a time against the first, vigilance may prevent the second, but against overfall or head of water the only adequate means is to make the obstruction permeable. An obstruction made by sinking driftwood composed of trees, their branches, and other smaller drift seems to meet the case.

The form of construction now undergoing experimental test was designed to resist all of these destructive agents.

Bank protection.—In bank protection the forms used have undergone but slight modifications since 1881, when the form adopted consisted of a mattress to protect

bank below low water and a revetment of stone from low water to the 20-foot e, leaving the zone above that level to be protected by willow growths.
t first a line of guide piles was driven to insure the correspondence of the shore e of the mattress with the curve of standard low water, but that has been changed, now the mattress is so placed that its shore edge corresponds with the curve ked by the water surface at the stage at which the work is done, and such litional width is given it as may be necessary to keep its river edge 120 feet from curve of standard low water, while the revetment of stone extends to the top of bank. This latter, however, may be placed in zones, as the bank is graded by action of the river, except in special cases where the bank is composed of mate-ls that will not grade to suitable slopes under exposure to the weather and the er. Such banks should be graded artificially and revetted without delay.
Prior to 1881 several other forms were tried.
1. That used at Sawyer Bend, 1872 to 1878, consisted of a foot dike with its crest feet above low water, built upon a foundation of brush placed in a trench dredged a depth of 8 feet below low water, and above the crest of the dike the bank was aded to a slope of 2 to 1 and revetted with stone.
On part of the reach stone spur dikes were built about 150 feet apart as a tem-orary protection, and being found efficient were adopted instead of the revetment.
2. A form consisting of loose brush in alternate longitudinal and transverse yers, and in widths from 40 feet to 60 feet placed below low water with a revet-ent of stone above, was used first at Devils Island and afterwards at Cairo, Kas-kia Bend, and Arsenal Island.
3. Still another form was used at Liberty Island, which consisted entirely of a one covering of the bank placed as riprap below low water and as a revetment bove. This was carried only to the level of the medium stage of river.
These forms have been exposed to the action of the river from ten to twenty years, nd though they have been more or less damaged, no finished protection has been estroyed or injured sufficiently to impair its efficiency.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

n works at Horsetail Bar, Carrolls Island, Twin Hollows, Pulltight, and Chesley Island.

HORSETAIL BAR, EAST, *June 30, 1894.*

MAJOR: I have the honor to make the following report of operations at Horsetail ar, east and west, Carrolls Island, Twin Hollows, east and west, Pulltight, and hesley Island, for the fiscal year ending June 30, 1894:
Mr. William S. Mitchell, assistant engineer, was in local charge of the work at arrolls Island, Pulltight, and Chesley Island previous to September 1, 1893.
Horsetail Bar, west.—Work was commenced on bank protection at this locality on ctober 9, 1893, and continued until the 22d of November following. It had been ntended that this work should be a continuation of the revetment already con-ructed from the river Des Peres to Dike No. 1, but owing to the space immediately elow the dike being occupied as a winter harbor by the steamer *Grand Republic*, the ew work was commenced a short distance below and carried to the end of the made round, a distance of 2,500 feet.
This protection consists of a continuous mat 130 feet wide, extending up to a 4-foot age. For a distance of about 1,958 feet from the upper end the bank was graded nd a stone revetment placed to a 12-foot stage. (For amount of work done see able No. 1.)
Horsetail Bar, east.—Work was commenced at this locality on May 18, 1894, and ntinued to June 26, 1894, when work was suspended.
Seven new hurdles were built between the old ones and were numbered 20¼, 22¼, ¼, 27¼, 29¼, 30¼, and 31¼. Hurdle No. 32¼ was commenced but not completed. ith the exception of Nos. 20¼ and 32¼ these lines were all curtained to a 12-foot age. Nos. 20¼, 22¼, and 24¼ were braced diagonally and Nos. 27¼ and 29¼ were engthened by a second row of clumps and stringers. (For amount of work done Table No. 2.)
Carrolls Island.—Work was commenced at this locality, on July 11, 1893, and sus-ded on August 11, 1893. During that period hurdles Nos. 2, 3, 4, and 5 were con-

structed and curtained to a 20-foot stage. Owing to shoal water the construction of HurdleNo. 1 projected at the head of the island, and of a hurdle across the chute just east of the island, was abandoned.

On May 1, 1894, a small force was moved to Carrolls Island and commenced strengthening Hurdle No. 5 by driving a second row of clumps of piles close up behind the first one. Owing to shoal water this was the only line that could be strengthened. (For amount of work done see Table No. 3.)

Twin Hollows, east.—At intervals during the first half of the fiscal year a small amount of scattered repair work was done on the revetment at this locality. (For amount of work done see Table No. 4.)

Twin Hollows, west.—Work was continued at this locality from the beginning of the fiscal year until November 20, when it was suspended for the winter. During that period hurdles Nos. 2½, 3, 3½, 4, 4½, 6, and 7 were constructed and with the exception of Nos. 2½ and 7 were curtained to a 12-foot stage. A considerable amount of bank protection work was also constructed. Much difficulty was experienced in building the hurdles at this locality on account of the shoal water at their outer ends, which practically made the conditions as regards the movement of plant and material the same as if the lines crossed a chute. The bank protection was also carried on under difficulties due to inaccessibility and soft, muddy banks. A considerable quantity of drift was sunk on these lines with the exception of on No. 6.

Work was resumed at Twin Hollows, west, on March 26, 1894, and continued until April 26, 1894, during which period lines Nos. 2½, 3, 3½, and 4 were braced diagonally and some drift was sunk on lines Nos. 2½, 3½, and 4. (For amount of work done see Table No. 5.)

Pulltight.—Work was continued at this locality until July 12, 1893, when it was suspended. It was resumed on August 12 following and continued with an interval of 6 days until November 17, when it was again suspended for the winter. During these periods work was done on hurdles Nos. 0, 0½, 0½, 1, 6, 7, and 8, the total amount being 4,675 linear feet of new work, 650 feet of old lines extended, and 750 linear feet of old work repaired.

With the exception of line 0, which consisted of three rows of clumps, and line 0½ these lines were all curtained to heights of from 12 to 20 foot stages. Hurdles Nos. 0 and 1 had their ends protected by buttresses built of brush and stone and 0½ by a cluster of clumps of piles.

On March 16, 1894, a force of pile-drivers commenced bracing the hurdles at Pulltight and repairing the gap which had been broken through No. 0. Lines Nos. 0 and 0½ were braced diagonally; 0½ was completed and had 270 feet on the outer end braced diagonally; No. 8 was extended 260 feet and had 1,085 feet of its length strengthened by a second row of clumps. (For amount of work done see Table No. 6.)

Chesley Island.—The work of reveting the head of the island was continued until September 25, 1893, when it was suspended for want of material.

Part of this work consists of a mattress built over a mass of drift and sand on the north side of the hurdle line; this has been considered as bank protection in the accompanying table of work done. The revetment here was very heavy in places and had a layer of spalls under the riprap where the bank was of soft material. (For amount of work done see Table No. 7.)

GENERAL METHOD OF CONSTRUCTION.

Hurdles.—The method of constructing a hurdle is as follows: A continuous woven mat, 112 feet wide, is built on way flats and sunk according as it is launched until the entire length has been completed. This mat is attached to clumps of piles, driven 100 feet above, by means of wire cables and is held floating in position by them until sunk, when the cables are taken up. A row of drift clumps of 4 piles each is driven along this mat at a distance apart of 10 feet from center to center of clumps. This row of clumps forms what is termed the drift row or hurdle proper, and is driven, as nearly as conditions permit of, to a 25-foot stage. It is sometimes strengthened by diagonal bracing or by another row of clumps driven close up behind.

At the outer end of the hurdle a T-head mat is constructed and sunk up and down stream; this has a width of 112 feet and a length of from 300 to 400 feet, and commences 100 feet above the upstream edge of the other mat. When this is completed and sunk the hurdle row of clumps is extended out 30 feet on it, and then a drift catcher consisting of about 8 clumps is driven upstream. This T-head mat acts as an apron to prevent scour from the channel end of the hurdle.

A mat about 350 feet long is also constructed on the shore end of the hurdle in order to prevent the bank from scouring, and above this is placed a stone revetment to about a 20-foot stage. This shore mat is usually built before the others. As soon as a hurdle is completed a curtain is usually built on the upper side and sunk in a

endicular position against the clumps in order to further check the current and e a deposit.

the ends of some of the hurdles at Pulltight ice-breakers were constructed. se were of two kinds. One consisted of a solid brush and stone buttress built inking one mattress on top of another until the desired height had been obtained, other of a cluster of about 60 clumps of piles in triangular shape pointing tream. In the first case the mattresses decreased in size from the bottom up.

ank protection.—Bank protection usually consists of a continuous woven mat, n 120 to 130 feet wide, built alongshore in way flats, and sunk as built. It is k so that the inshore edge will come where the plane of a 4-foot stage of water ersects the bank, and above that is then revetted with rock. Sometimes, when it ecessary to protect a flat, soft bank, a mattress is built in place as a foundation the stone, and this may be either a woven or grillage mattress.

At Twin Hollows, west, three kinds of mattresses were used in such a place, i. e., oven willow, grillage, and willows woven with wire cables.

Drift mats.—Drift mats are built over bodies of drift in order to sink them. They e always grillage mats, and are built of such thickness as is required to bear the eight of the stone necessary to sink the drift below.

DETAILS OF CONSTRUCTION.

Foundation mattress.—The way flats being made fast together, a header built up f a number of pieces of heavy brush is constructed on the lower end of the ways. To this are fastened at right angles weaving poles at a distance of from 4 to 6 feet apart, depending on the size of the weaving brush to be used; a second pole like the first is then fastened on top of these, and the whole well fastened with wire and spikes. The weaving then commences by working the brush under and over every other weaving pole and alternating across the mat so as to give it strength against tearing apart lengthwise in sinking. As the brush is placed it is fastened to the weaving poles with 20-penny nails, one being put in every third piece of brush. As soon as the length of the ways is completed in this manner extra poles are fastened along the second weaver from the upper edge and thoroughly fastened to it; the cable is then made fast to this, the upper end having been previously fastened around one of the piles of a clump driven 100 feet above by means of a chain and allowed to sink to the bottom.

Small cables are put in across the mat where the sinking cables come, and are fastened with a hitch around every alternate weaving pole. Sometimes several extra poles are fastened on a mat, and also wire cables running longitudinally, this depending on the current and the depth of water the mat is to sink in. As soon as the section of mattress on the ways is completed it is launched by pulling the flats from under it until only the edge remains unlaunched. New poles are then spliced to the ones in the section already built and the same process is gone through again and repeated until the mat is finished, when another header is put on and it is launched clear of the flats. When the mat is of considerable length it is sunk as the construction progresses. Before sinking, the upper edge of the mat is made fast by slip lines to flats, so hung from the piling as to float just above it. These slip lines are let go as soon as there is sufficient stone on the mattress to make it sink quickly. In weaving, the butts of the brush are always placed pointing out from the center of the mat.

Shore-protection mattress.—This is constructed in a similar manner to the foundation mattress, but is fastened either to piling along the inshore edge by means of yokes or to dead men buried in the bank by means of lines.

Clumps of piles.—These usually consist of 4 piles to the clump, driven at such distance apart as will give the greatest spread without causing them to break when drawn together. The piles are pulled together by a pile-driver and then bound securely with a wire rope wrapped three or four times tightly around, and fastened to them by 6-inch and 8-inch spikes driven nearly home and then turned over the wire so as to clinch it.

Curtains.—The construction of a curtain is as follows: A stringer of single poles is first fastened along a hurdle line at convenient height; then a number of poles are fastened to this at right angles and of such length as to reach the bottom of the river when sunk and leaving several feet extending up above. Outside of these poles a second row of stringers is placed over and fastened to the first. The ends of the poles rest on flats, and crosspieces of light saplings are nailed to them at intervals, beginning with 3 inches at the bottom and increasing to 6 inches at the top, and this is carried up to such distance on the poles as will bring the curtains to the desired height when sunk. A sufficient quantity of stone is then fastened by wire to the lower end of the curtain, the flats are pulled out from under it, and it sinks, being drawn down against the piling by the current. The fastenings connecting the perpendicular poles with the stringers are then cut, allowing the former to slide down between the latter should a scour occur.

Diagonal bracing.—Two diagonal braces inclined at from 35° to 45° with the horizontal are placed against each drift clump of the hurdle.

To hang these braces, three piles for a brace clump are first driven opposite and below each drift clump in triangular form, the apex being upstream and the base running in line parallel with the hurdle. A clevis is then fastened through the end of the brace, which is lifted up by a pile-driver and hung over one of the piles in the base of the pile clump. The brace is worked down until the butt rests on the mat, and the head is then lowered against the clumps, to be braced where it is bolted to one or two of the piles of same by 1-inch bolts. The brace from the right-hand pile of the base of brace clumps is hung over to the drift clump on the right of the one directly above, and the brace from the left-hand pile of same base to the clump on the left of the one above, so that when the bracing is finished each clump in the drift row or hurdle proper has its braces spread at the butts and crossing the braces to the clumps on its right and left, thus getting support against side as well as against direct pressure. The piles of brace clumps are then drawn together and wired. The distance between the upstream pile of the brace clump and the other two depends on the depth of water, and the distance between the piles in its base is from 3 to 5 feet.

Strengthening clumps.—These are driven from below a hurdle line as close up to the center of the spaces between the drift clumps as the pile-driver can get, and of the same construction as the latter, but usually left out to a lower stage of river.

The upper piles of these clumps enter the ground above the downstream piles of the drift clumps, but when they are clumped they cross the latter. A stringer is then placed above the intersection of these piles and bolted to the back row, so that the hurdle row gets immediate support when any strong pressure comes against it.

RESULTS AND OBSERVATIONS.

There has been considerable filling all along the hurdles during the past year, especially at the upper end of Pulltight, where it amounts to 25 feet in places. At Twin Hollows, west, there has been a deposit of from 6 to 12 feet, and at Horsetail Bar, east, during the past two months, while the work was in progress, there has been a filling of from 4 to 8 feet. The quickest and heaviest deposits have been on the Illinois side of the river, but the material is entirely different on the two sides of the river, it being principally silt on the Missouri side and sand on the Illinois. The filling is greatest on the outer ends of the hurdles, but is fairly uniform in to shore. The greatest deposit at the beginning of the season was found below the cluster of clumps at the outer end of line 0½, Pulltight, which were driven late last fall.

The following tables show the work done in detail:

TABLE NO. 1.—*Work done at Horsetail Bar, west.*

Bank-protection mattress constructed and sunk (2,485 by 130 feet)	sq. feet	323,050
Bank revetted above mattress (1,958 linear feet)	do	48,950
Bank excavated	cubic yards	1,400
Piles driven		19

TABLE NO. 2.—*Work done at Horsetail Bar, east.*

	At Hurdle No.—				
	20½.	22½.	24½.	27½.	29½.
Hurdle completed (linear feet)	220	430	670	950	880
Hurdle braced (do)		430	625		
Hurdle strengthened (do)	200			880	830
Foundation mattress constructed and sunk	325×112 112× 80	615×110	745×110 105×112	40× 90 265×110 1015×112	1220×110 110×112
Shore mattress constructed and ballasted	325× 30				
Curtain constructed		420× 13	c32×12.3	852×11.6	850×9.7
Revetment at end of hurdle (sq. feet)	14,625	4,622	14,760	15,036	14,005
Excavation (cubic yards)			1,110	1,266	
Piles driven (number)	202	427	528	855	795
Braces placed (do)		79	118		
Stringers placed (do)	6			33	18

TABLE No. 2.—*Work done at Horsetail Bar, east*—Continued.

	At Hurdle No.—			Total.
	30½.	31½.	32½.	
Hurdle completed.....linear feet..	670	520	.....	4,340
Hurdle braced .....do....	.....	.....	.....	1,055
Hurdle strengthened.....do....	.....	.....	.....	1,900
Foundation mattress constructed and sunk.....	995×112	40×80 990×112 70×50 108×40 135×65	550×112	*7,450 †804,485
Shore mattress constructed and ballasted	.....	.....	.....	*325 †9,750
Curtain constructed.....	600×9.1	520×7	.....	*3,819 †40,462
Revetment at end of hurdle.....square feet..	3,620	24,576	9,180	100,424
Excavation .....cubic yards..	.....	.....	.....	2,376
Piles driven .....number..	366	291	47	3,536
Braces placed .....do....	.....	.....	.....	197
Stringers placed .....do....	.....	.....	.....	61

* Linear feet. † Square feet.

TABLE No. 3.—*Work done at Carrolls Island.*

	At Hurdle No.—				Total.
	2.	3.	4.	5.	
Hurdle completed.....linear feet..	800	670	450	340	2,260
Hurdle strengthened.....do....	.....	.....	.....	280	280
Foundation mattress constructed and sunk.....	1,030×85	1,000×100	800×100	650×100	*3,480 †332,550
Curtain constructed .....linear feet..	800	670	450	340	2,260
Revetment at end of hurdle.square feet..	3,000	3,600	4,000	8,400	19,000
Piles driven	289	303	189	263	1,044

*Linear feet. †Square feet.

TABLE No. 4.—*Work done at Twin Hollows, east.*

	Square feet.
Bank revetted (scattered in repairing old work)	9,420

TABLE No. 5.—*Work done at Twin Hollows, west.*

	At Hurdle No.—				
	2½.	3.	3½.	4.	4½.
Hurdle completed.....linear feet..	270	425	705	650	425
Hurdle braced .....do....	240	425	685	630	.....
Foundation mattress constructed	290×100 385×60	390×60 410×90	600×100 180×60 250×94	607×100 395×60	422×70 400×100
Foundation mattress sunk	290×100 385×60	390×60 410×90	600×100 180×60 250×94	607×100 395×60	422×70 400×100
Shore mattress constructed and ballasted.....	170×30	.....	.....	150×60 60×40 80×30	100×50
Drift mattress constructed and ballasted.....	215×60 165×30 240×50	60×40	235×50	230×50 246×40	270×35 76×30 135×26
Curtain constructed.....	.....	420×15	649×16.7	626×16.6	427×12.4
Revetment at end of hurdle.....square feet..	8,000	6,500	8,000	16,150	12,410
Piles driven .....number..	180	306	500	408	196
Braces placed .....do....	47	33	117	97	.....
Excavation for hurdles.....cubic yards..	.....	.....	.....	.....	1,000
Excavation for bank protection .....do....	.....	.....	.....	.....	.....
Bank protection mattress constructed and sunk, square feet.....	.....	.....	.....	.....	.....
Bank revetted and protected.....	.....	.....	.....	.....	.....

TABLE No. 5.—*Work done at Twin Hollows, west*—Continued.

	At Hurdle No.—			Total.
	5½.	6.	7.	
Hurdle completed ..... linear feet..	.....	165	260	2,900
Hurdle braced ..... do....	.....	.....	.....	1,980
Foundation mattress constructed	.....	185×100 250×60 67×50	170×60 145×85	*5,146 †420,015
Foundation mattress sunk	.....	185×100 250×60 67×50	170×60 205×85	*5,206 †425,115
Shore mattress constructed and ballasted	.....	105×100	100×68	*720 †38,500
Drift mattress constructed and ballasted	.....	.....	530×50	*2,402 †107,080
Curtain constructed	.....	230×3	.....	*2,352 †33,515
Revetment at end of hurdle ..... square feet..	6,643	.....	2,893	60,596
Piles driven ..... number..	.....	91	102	1,783
Braces placed ..... do....	.....	.....	.....	294
Excavation for hurdles ..... cubic yards..	256	.....	.....	1,256
Excavation for bank protection ..... do....	.....	.....	.....	800
Bank protection mattress constructed and sunk, square feet	.....	.....	.....	241,710
Bank revetted and protected	.....	.....	.....	*2,930 †64,149

* Linear feet. † Square feet.

TABLE No. 6.—*Work done at Pulltight.*

	At Hurdle No.—				
	0.	0¼.	0½.	1.	4.
Hurdle completed ..... linear feet..	550	1,060	1,400	550	.....
Hurdle repaired ..... do....	75	.....	.....	750	.....
Hurdle braced ..... do....	550	1,060	270	1,040	.....
Hurdle strengthened ..... do....	550	.....	.....	.....	.....
Foundation mattress constructed	750×96	1,100×96 500×112	1,360×100 260×112 90×50	550×100 250×112	.....
Foundation mattress sunk	750×96	1,100×96 500×112	1,360×100 260×112 90×50	700×100 250×112	.....
Shore mattress constructed and ballasted	.....	.....	.....	225×100	.....
Buttress mattress constructed and ballasted	80×50×6 65×50×6 50×40×4	.....	.....	70×60×2 87×50×3 55×51×3	.....
Curtain constructed	.....	1,000×12	1,400×11.5	1,780×15.7	1,170×16.5
Revetment at end of hurdles ..... sq. ft..	27,930	27,700	19,685	5,280	.....
Piles driven ..... number..	808	813	668	716	.....
Braces placed ..... do....	83	256	43	163	.....
Bank revetted	.....	.....	.....	.....	.....

	At Hurdle No.—			Total.
	6.	7.	8.	
Hurdle completed ..... linear feet..	650	1,200	1,235	6,645
Hurdle repaired ..... do....	.....	.....	.....	825
Hurdle braced ..... do....	610	.....	.....	3,530
Hurdle strengthened ..... do....	.....	.....	1,085	1,635
Foundation mattress constructed	700×95	2,000×100	1,100×110	*8,660 †873,720
Foundation mattress sunk	770×95	2,000×100	1,100×110	*8,850 †895,370
Shore mattress constructed and ballasted	150×65	.....	300×110	*675 †65,250
Buttress mattress constructed and ballasted	.....	.....	.....	‡3,013.6
Curtain constructed	1,650×7	1,400×20	1,000×25	*9,400 †139,931
Revetment at end of hurdles ..... square feet..	.....	.....	11,160	91,755
Piles driven ..... number..	459	540	845	4,849
Braces placed ..... do....	119	.....	.....	664
Bank revetted	.....	.....	.....	*450 †33,240

* Linear feet. † Square feet. ‡ Cubic yards.

TABLE No. 7.—*Work done at Chesley Island.*

	Linear feet.	Square feet.
Revetment placed	632	38,375
Drift mattress constructed	200	26,750
Drift mattress ballasted	200	26,750
Curtain constructed	60	450

TABLE No. 8.—*Summary and distribution of work done during fiscal year ending June 30, 1894.*

	Hurdles.	Bank protection.
	Lin. ft.	*Sq. feet.*
Total work done	16,145	785,644
Work done at Horsetail Bar, west	.....	372,009
Work done at Horsetail Bar, east	4,340	.....
Work done at Carrolls Island	2,260	.....
Work done at Twin Hollows, east	.....	9,420
Work done at Twin Hollows, west	2,900	305,859
Work done at Pulltight	6,645	33,240
Work done at Chesley Island	.....	65,125
Hurdle repaired at Pulltight	825	.....

The ruling channel depths during the low water of 1892 and 1893 are shown in the following table, all being reduced to standard low water:

	Sept. 25, 1893.	Sept. 28, 1893.	Sept. 26, 1892.
	Feet.	*Feet.*	*Feet.*
At Arsenal	6.9	.....	5.8
At Quarantine	9.4	.....	.....
At Pulltight	8.4	.....	3.8
At Meramec	9.4	.....	5.3
At Sulphur Springs	4.4	.....	11.8
At Waters Point	.....	6.4	.....
At Bushberg	.....	9.4	.....

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER.

On works at Fort Chartres and Rush Tower.

RUSH TOWER WORKS, *June 30, 1894.*

MAJOR: I have the honor to submit the following report on the progress of the works for the improvement of the Mississippi River near Fort Chartres and Rush Tower during the fiscal year ending June 30, 1894.

FORT CHARTRES WORKS.

Revetment.—The revetment placed on the Illinois bank below Sycamore Landing in the fall of 1892 is in excellent condition and has peformed its office most satisfactorily.

During the high-water season of 1893 the river graded the bank above the mattress to a slope favorable for the reception of stone, which, in September and October, was placed between the levels of the 10 and 22 foot stages of the river (St. Louis

gauge) over 3,750 feet of the bank from the upper end of the mattress, leaving 1,7 feet yet to be revetted, although in this portion of the work slight repairs we made to the narrow riprap placed in 1892.

The stonework should be extended to the end of the mattress, as the bank is no ready to receive it. Below the mattress, for 9,000 feet to Fort Chartres Landing, th heavily wooded bank is caving rapidly and needs protection.

Opposite the landing 3,500 feet of its east bank to the foot of Bruce Island is als undergoing severe erosion, although the upper half of this stretch has not yet bee cut back to the 2,500-foot channel limit. The outside of the bar above the island i also cutting.

This general erosion is evidence that the sy tem of hurdles next the Missouri shore, although too recently constructed to be silted up to the desired level, is having a very appreciable effect in contracting and on the direction of the channel.

HURDLES.

During the year 6 hurdles, Nos. —3, —2, —1, 0, 1, 1½, have been added to the Fort Chartres system. Of these, 5, Nos. —3 to 1, inclusive, were begun last fall and are spaced as follows: 2,200 feet between Nos. 1 and 2, 1,800 feet between Nos. 1 and 0, and 1,500 feet between the others. In May, Hurdle No. 1½ was constructed halfway between Nos. 1 and 2.

These hurdles all begin within 100 to 200 feet of the Missouri shore, or as close as piles could be driven to the rock ledge projecting under the bed of the river from the adjacent bluff, and they extend out 1,200 to 1,900 feet to the west limit line for the channel. The outer ends of Nos. —3 to 0, inclusive, are on this line, but Nos. 1 and 1½ end at the high banks of Bruce Towhead and Island, respectively, the former bank being protected with a mattress and heavily revetted with stone to the top.

The main shore connections for all lines but No. 1 consists in part of low stone dikes brought to the 5-foot stage, and founded on each of these dikes, except in line No. —2, is a series of heavy stone piers 25 feet between centers, raised to a 23-foot level. There are 9 piers in line No. —3, 5 each in Nos. —1 and 0, and 6 in No. 1½. Similar connections will be made in lines Nos. —2 and 1 should they be needed. The use of such piers is thought to be preferable to solid stone dikes for permeable works, especially at high stages of water exerting maximum pressures.

Above all lines, except No. 1½, drift has been sunk in one or two tiers 35 to 50 feet in width, and in some instances supplemented with heavy brush mattresses up to the level of a 12-foot stage. Above hurdles Nos. —3 and —1 enormous masses of drift remain unsunk.

At the outer ends of Nos. —3 and —2 T-head mattresses, 300 by 100 feet, have been sunk, and heavy triangular buttresses, 50 by 50 feet, of brush and stone, raised to 12 and 15 foot levels and surrounded by clumps of piles, have been placed.

All of the hurdles are founded on the usual brush mattresses, about 100 feet in width, woven continuously on flats and sunk, except for 3,155 feet (combined length) in lines Nos. —1, 0, and 1, which were fabricated last fall in place on the dry sand bar. It was impracticable to weave this portion of the mattress, so they were made in two cross layers of brush bound between top and bottom grillage, and were ballasted with stone, all materials being hauled to place on trucks running on tracks of willow poles laid on the sand, a pile-driver furnishing the necessary power. This construction was tried as an experiment, but is not recommended for general use, for the reasons that it is inferior in strength to the woven mattress; its top grillage renders it easily liable to injury from passing drift, and when torn it quickly breaks up; it is loose and does not hold stone well, especially on steep slopes or banks caving under one edge of the mattress, as is often the case. Could the mattress be woven on the dry sand bar for a commensurate cost, the advantage would be great, but the ultimate gain with a loosely laid mat is not apparent.

The woven mattresses were sunk on ¾-inch wire cables leading to the bases of anchor piles driven 100 feet above the upper edge of the mattress. The anchor piles were spaced 15 to 100 feet (average 30 feet) apart, corresponding to the strength of current in which the sinking had to be done. The cables were recovered by special releasing devices and used repeatedly, 12 cables with chains, trippers, and shackles making a full complement for one mattress gang.

For clumping the piles which were all driven through the foundation mattresses, bolts were rejected altogether because of their tendency to split the piles under strain and the slow rate at which the latter could be bored for them. Cables were used instead, 18 to 30 feet in length. They were made on the ground of 18 strands No. 14 galvanized wire, and cost about 1 cent per linear foot at present prices for labor and material. In use from 3 to 5 full turns of cable were taken around each clump, each turn being drawn taut by a pile-driver engine and caught to each pile with a 6-inch by ¾-inch boat spike driven well in above the cable, the head of the spike being clamped hard down on it. Above the top turn on each pile an 8-inc

ıch spike was driven and turned down over all. The eyes at the cable ends lso secured to the piles.

i fastening is cheaper than bolts, is much more quickly placed, is more flexible strain, and has no tendency to injure the piles; in fact, the reverse is the case. ;tempt was made to pull several of them off, but the Mundy hoisting engine on le-driver was not able to loosen them except one strand at a time. So far as n not a single cable has given way, although huge fields of drift have lodged st the hurdles.

ts, 1-inch diameter, were used with all cross braces and as top fastenings for ıraces, although a few of the latter at the west end of line No. 1½ were secured cables as an experiment. Clevises of 1½-inch iron were used to secure the lower ɔf all braces.

ɔ distribution of the piling and the condition of the various hurdles at the close e year, beginning with the hurdle furthest upstream, are as follows:

rdle No. 3.—This is the head line, and strongest in the system. It is 1,225 feet tal length, of which 22 5 feet next shore are occupied by the stone dike and nine described.

e piling consists of a principal row of clumps, 8 feet between centers, of 7 piles , driven in pairs, with the odd pile upstream. The latter pile carries a brace ing to the top of a pile 10 feet above the clump, and 10 feet above this line of e piles is a second similar row, the space between the two being filled to the t stage with brush and stone. This low dike extends from the shore connection ıe west to the buttress into which it spreads at the east end of the line. A h curtain to the 12-foot stage was placed above the dike.

low the clumps (10 feet) a third row of single piles was driven, from which ss lead to the clumps, and over the tops of the braces cross braces were placed, ıing from the third to the first row of single piles, to both of which, as well as e clumps, they were bolted.

e hurdle was entirely completed during the fall season and contains 1⅛ sticks of timber per linear foot of line. In the spring the drift which had collected e it was sunk and the tops of the piers, which at first had been raised to the ot level only, were raised to 22 feet after having been slightly damaged at a ot stage of river by drift dragging over them.

e hurdle is in excellent condition and a large quantity of drift remains unsunk ɣ its entire front.

e remaining hurdles were constructed alternately with (lines Nos. —2, 0, and 1½) without (lines Nos. —1 and 1) braces or cross braces, to determine the rela- efficiency of these methods of construction, of which the second seems the ɔer and quicker to build, and it being thought also that a brace heeled against ıck pile, with a loose clevis and with the tendency of its top bolt to split out r strain, might prove an inferior element in the strength of the structure to the stick well driven as a pile.

aid in the comparison each hurdle was constructed with an allowance of one of pile timber for each foot in length of line. This necessitated a slight dif- ce in the spacing of the clumps, 10, 9, and 8 feet all being used when the same ɛr of sticks were called for in the construction of the bent as the combination ɜ unit of structure in both rows may be called. The arrangements are given ɜ following table:

	Distance between rows of clumps.	Piles in clump in upstream row.	Piles per clump in downstream row.	Braces placed.	Cross braces placed.	Total sticks pile timber per bent.	Space between bents.	Remarks.
	Feet.						*Feet.*	
No. -2	25	5	3	1	1	10	10	
No. -1	5	4	4	0	0	8	8	Clumps staggered.
No. 0	25	4	3	1	1	9	9	
No. 1	5	4	4	0	0	8	8	Clumps staggered same as No. —1.
No. 1½	25	4	3	2	0	9	9	

east one pile in each clump in the upstream row reaches to the 25-foot level, ɔne of the other piles are below 20 feet. The cross braces are placed at about ɜter level and rest on the heads of the braces, which were never set at a higher than 45 degrees. These levels and the arrangement of braces and cross braces also to Hurdle No. —3.

been placed in the fall and the latter in May, on account of the heavy flow of over the dike, due to the draw toward the Missouri shore of the current arou outer end of Hurdle No. -2, and between that hurdle and the bar at the outer this line.

One row of 3-pile clumps, 10-foot centers, was driven over a portion of th and the mattress was extended full length in the fall. The piling was also cut to a 12-foot stage. During the winter the piling was broken by ice near th souri shore, and the bar mattress was damaged by drift. Both of these in were repaired in the spring, the latter by weaving a section of mattress above carrying the hurdle around the injured place to avoid the deep water immed below and due to it, and the former by restoring the piling with heavy 4-pile cl 8-foot centers, supported by a second similar row, close below, in which the c were driven in the spaces between (were staggered with) those in the uppe All of the fall work was strengthened in this manner, the upper row was ext to the end of the line, and the lower row to within 500 feet of that point, w was abandoned on account of water too shoal to float the drivers.

For the same reason the T-head mattress and the buttress could not b structed.

Drift has been sunk above the hurdle to the 12-foot stage and there yet rem field 250 feet wide along its entire length.

Hurdle No. 0.—The total length of this hurdle is 2,150 feet, of which 150 the west end are occupied by a stone dike and 5 piers; 450 feet of the hurdl east end on the sand bar is void of piling, although the foundation mattress w there during the fall, when also the piling, begun as a single row of curtained clumps, was driven from the Missouri shore to the bar. During the winter th half of this work was badly damaged by ice, but it was repaired in the sprin 4-pile clumps, 9-foot centers, strengthened with braces and cross braces from a row of 3-pile clumps driven 25 feet below. The double row was extended to th bar line 1,000 feet from the outer end of the mattress, and the front row was 550 feet farther. Beyond this point a high-water stage (27 feet, St. Louis g will be required to complete the work.

The T-head and buttress, of course, are lacking.

The drift above the line was sunk to the usual level.

Hurdle No. 1.—The hurdle is 1,700 feet in length, but in 200 feet of this ne rock shore piles could not be driven, as in the case of the piers for No. —2 a dik not yet seem necessary, as the hurdles above seem to check the current here e ally, the only additional water entering the pool above this hurdle coming fr main river running upstream across the bar and around the upper end of th head at stages over 12 feet. The piling extends complete to within 75 feet tow-head; part of it was driven last fall, was broken by ice in the winter, a repaired, strengthened, and extended in the spring. It consists of a double 4-pile clumps, staggered as in No. —1.

The tow-head bank at which the hurdle ends was protected by a mattr

Hurdles Nos. 2 and 3.—Constructed in 1892. The smaller gap reported last year at the west end of the line was closed. No other work was attempted on either of these lines owing to the excessive depths still found through their main gaps.

The location of the hurdles and the depths of water found throughout this reach are shown on the chart accompanying the report for May.

It will be seen that a very considerable deposit has been gained by the hurdles and that the bars below the series have been augmented, with lessened depths along the west shore of Bruce Island, despite the general low water of the year, the spring rise (to 23 feet only) affording the only opportunity to collect sediment, as the June flood has not yet appeared.

The present state of the hurdles insures during the low-water season the concentration of the entire flow of the river at this point in the channel between Bruce Island and the Illinois shore, which can only result in at least a partial relief from the obstructing bar. Much greater effect might have been expected had the usual June rise occurred.

The work of the year was begun September 1 and continued until November 24, under Mr. J. O. Holman, assistant engineer.

It was resumed March 15 and carried on until the close of the year.

At the end of May the force was reduced from 350 men and 12 pile-drivers, to 30 men at Fort Chartres for stonework done in June, and 75 men and 2 pile-drivers for work at Rush Tower. The remainder of the force was discharged and the plant was placed in harbor at the latter work.

RUSH TOWER WORKS.

During October and November the revetment of the Illinois bank between Osborne Field and Durfees Landing was extended upstream 1,970 feet, with a protection mattress to low-water mark and with stone to the level of a 10-foot stage. In addition, about 3,000 linear feet of the stonework placed in 1892 above the old mattress, was repaired and raised to the 16-foot contour.

The repair of Hurdle No. 3 of this system began May 29 and continued until June 30.

A foundation mattress was laid anew in both gaps in this hurdle. The piling was entirely restored in the east gap, 275 feet wide, and for the west gap, 330 feet wide, a screen of 4-pile clumps was driven entirely across it, but 175 feet above the old line to avoid the deep water encountered there The end connections between this screen and the old work have not yet been made.

The work is too recent to have exerted any influence upon the channel in the vicinity.

The amount of the various kinds of work done on each hurdle, the expenditures in labor and materials, and the service of plant, are given in the following tables:

TABLE NO. 1.—*Work done at Fort Chartres.*

HURDLES, WEST SHORE.

	No.—3.	No.—2.	No.—1.	No. 0.	No. 1.	No. 1½.	No. 2.	Total.
Hurdles.....linear feet..	1,225	1,550	1,900	1,600	1,700	1,400	175	9,550
Piles driven.....number..	1,240	1,312	1,465	1,237	1,108	1,005	133	7,500
Piles driven.....depth, feet..	15,573	17,109	20,817	17,435	14,882	17,410	1,532	104,758
Braces.....number..	210	130	.....	81	.....	270	.....	691
Cross braces.....do....	127	142	.....	114	1	.....	.....	384
Foundation mattress.linear feet..	1,005	1,585	2,105	2,270	1,885	1,468	.....	10,298
Foundation mattress .. sq. feet..	100,500	156,650	196,075	218,600	182,320	165,880	.....	1,020,025
T-head mattress ....linear feet..	200	285	.....	.....	.....	.....	.....	485
T-head mattress....square feet..	20,000	31,350	.....	.....	.....	.....	.....	51,350
Drift mattress.....linear feet..	1,951	1,208	2,000	1,959	1,972	864	.....	9,954
Drift mattress.....square feet..	84,740	43,370	82,535	92,982	92,657	22,464	.....	418,748
Curtain .....linear feet..	1,000	.....	550	750	.....	.....	.....	2,300
Revetment .....do....	170	.....	.....	.....	340	.....	.....	510
Revetment .....square feet..	4,080	.....	.....	.....	4,760	.....	.....	8,840
Shore dikes with piers above, linear feet	225	.....	150	150	.....	150	.....	675
Shore dikes with piers above, number.....	9	.....	5	5	.....	6	.....	25

BANK PROTECTION, EAST SHORE.

	Linear feet.	Square feet.
Station 0 to 37 + 50, extension of revetment	3,750	203,370
Station 37 + 50 to 55, old revetment repaired	300	5,400

TABLE NO. 2.—*Work done at Rush Tower.*

HURDLE No. 3, WEST SHORE.

Length of hurdle	linear feet..	400
Piles driven	number..	881
Piles driven, depth	feet..	14,485
Foundation mattress	linear feet.....	872
	or square feet..	80,183

BANK PROTECTION, EAST SHORE.

	Linear feet.	Square feet.
Protection mattress	1,970	236,400
Revetment above new mattress	1,970	48,070
Revetment, extension of old	2,965	90,170

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers.

REPORT OF MR. E. D. LIBBY, ASSISTANT ENGINEER, ON PROCURING BRUSH.

STE. GENEVIEVE, MO., *June 30, 1894.*

MAJOR: I have the honor to submit the following report of operations at procuring brush for the fiscal year ending June 30, 1894:

At the beginning of the fiscal year the brush party, consisting of 14 teams and 52 laborers, was engaged in procuring brush at upper Jim Smith's.

In order to supply the brush that was needed during the first half of the year, frequent changes of location were necessary, partly on account of the soft condition of the ground due to the high water of June, and partly from the small amount of brush that could be found at any one place.

The entire quantity of brush that was procured in the first half year was obtained at various points between Lower Horsetail Bar (East side) and Chesley Island.

The force remained the same as at the beginning of the year until August 21, when the number of teams was increased to 25 on account of the long haul. From this time to the close of the working season of 1893 frequent changes were made in the number of teams, in order to accommodate the force to the demand for brush and to the nature of the localities at which it was obtained. The greatest number employed during the fall season was 32, while procuring brush at Lower Horsetail Bar.

No material change was made in the number of laborers.

The force was disbanded for the winter on November 6, and the outfit was taken to Winter Harbor, at Chester, Ill.

Active operations for the season of 1894 were commenced at Turkey Island on March 15, the force consisting of 17 teamsters with teams and 40 laborers. The force was increased or reduced as the demand for brush and the conditions, at the various localities from which it was obtained, required.

The largest force during the spring season consisted of 32 teamsters with teams, and 49 laborers with their foreman and boarding crew.

During the last half year brush was procured at the following localities:

Turkey Island, Rush Tower Towhead, Lee's Island, Liberty Island, Hat Island, Grand Tower Towhead, Wittenberg, and Hamburg Island.

The force was disbanded on June 16 at Hamburg Island, and on June 19 the outfit was towed to Little Rock, Mo., and laid up, a few men being retained to care for the property.

Quarter barges with portable shanties were in use until September 21, on which date quarter boat No. 1 was received and put in service, and barge No. 25, with quarters, was sent to the engineer depot.

Derrick boat No. 1 was in service for loading brush during the larger part of the year. On the 8th of May derrick boat No. 2 was received and put in service, but

its use was discontinued after loading one barge, and it was sent to the engineer depot for repairs. It was received again on May 29, and was in service until the work closed.

There were procured during the year 32,691.89 cords of brush.

Very respectfully, your obedient servant,

E. D. LIBBY,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. E. D. LIBBY, ASSISTANT ENGINEER, ON PROCURING RIPRAP AT LITTLE ROCK, MO.

STE. GENEVIEVE, MO., *June 30, 1894.*

MAJOR: I have the honor to submit the following report of operations at procuring riprap at Little Rock, Mo., during the fiscal year ending June 30, 1894:

At the beginning of the year work was in progress at the lower quarry by a small force of men, the drilling being done by hand and the loading by a pile-driver fitted up as a derrick boat.

On July 27 one steam drill was put in service, and another on September 28.

Steam for operating these drills was at first taken from the boiler of the derrick boat, but this arrangement, besides being inconvenient on account of the long lines of pipe required to reach the drills, made too great a demand upon the boiler, and a self-propelling engine with boiler was hired, as a temporary expedient, to run the drills, and with so good success that it was kept in service during the remainder of the fall season. By its use much better results were obtained, as the boiler could at all times be kept in the immediate vicinity of the drills, thus doing away, in a great measure, with condensation of steam, and avoiding frequent changes of long leads of pipe.

With a few short delays for repairs the steam drills were in use until the work was closed for the winter.

The very low water that prevailed during the latter part of the working season of 1893 made it necessary to lower the track approaches to the derrick in order for the boom to reach the stone boxes. With this change, and some additions to the tracks in the quarry, loading by steam was carried on until active field work was closed for 1893.

In order to permit working at the upper quarry, the force was considerably increased and the shore parties put in service on July 10.

During the first half of the year the work at the upper quarry consisted largely in clearing away the earth in front of the ledge and in forming a terrace from which the work can be carried on at high stages of the river.

Late in September the den and for riprap became greater than could be filled by the force at the lower quarry, and in order to supply the amounts needed, quarrying was begun at the upper quarry, drilling and loading being done by hand.

On the 1st of October, barge No. 25, with quarters, was received for temporary service at the upper quarry, and the force at that locality was increased so as to give a capacity of about 300 cubic yards of riprap per day, and from this time on the procuring of riprap was carried on at both quarries until the close of the season of 1893.

On December 1 the force was reduced to about 20 men, who, during the winter and until active field work was resumed on March 17, were employed in clearing away spalls, stripping the earth from the top of the ledge, and constructing a stone pier for a site for steam derrick.

The force was increased on March 17 by the employment of 20 laborers, and active work for the season of 1894 was begun at the lower quarry. A small derrick with a boat crab for a hoist was used for loading the barges, but this arrangement proved only indifferently successful, as the derrick, designed for other purposes, was too light for the heavy service of loading. Its use was discontinued on April 6, and the force being further increased was transferred to the upper quarry, where drilling by hand and loading by barrows could be best carried on, but not with the same economy in cost as with steam power.

On the 23 of April a steam boiler and derrick, to be used with a steam hoist, were received from the engineer depot, and a small force was detailed to put them in position in the lower quarry, and fit them up for service. This work had so far advanced by May 9 that the boiler was ready for use, and one steam drill was started, and with slight interruptions was kept running as long as there was any demand for riprap.

The derrick was set up and made ready for loading by steam power, but pending the arrival of a steam hoisting engine was not immediately put into service.

During July, 1893, a magazine was constructed at a safe distance from bo ries, to be used in storing dynamite. The old magazine is used in storing e and caps.

Considerable work for the improvement of the quarries has been done du year, the cost of which has been charged against the riprap procured du year, and without an immediate return for the outlay, but the result of this w be to lessen the cost of the riprap that shall be taken from the quarries, s improvements are of a general character and their results lasting.

With the appliances used for loading by steam, in the first half year, 400 cut of riprap were readily loaded in a day of eight hours.

During the latter part of the year, when the loading was done by the new with a hand power hoist, 280 cubic yards of riprap was a day's work.

Employing the same force and loading by barrows 250 cubic yards could b in ten hours.

When the steam hoisting engine shall be put in service, it is confidently e that two fully-loaded barges, 580 cubic yards, per day will be easily loaded

The advantages of steam drilling over hand drilling are very marked. Th drilling is very much reduced, and, as a matter of economy alone, all holes for should be driven by steam drills.

Very respectfully, your obedient servant,

E. D. LIBBY,
Assistant I

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT, ON OPERATIONS AT U. S. E DEPOT.

UNITED STATES ENGINEER DEPO
St. Louis, Mo., June 30

MAJOR: I have the honor to submit the following report of operation engineer depot during the fiscal year ending June 30, 1894:

The construction and repairing of equipment was continued throughout t though the force was largely reduced during the month of May.

This work is divided into two classes: First, that which increases the plant, and, second, ordinary repairs required to keep the plant in a ser condition.

CONSTRUCTION AND EXTRAORDINARY REPAIRS.

Towboats.—The repairs upon the towboat *Gen. Gillmore*, which were b the Mound City ways in February, were completed at the engineer depot in

The hulls of Nos. 2, 5 to 13, 16, 18, 19, and 20, built in 1881, were found unserviceable and retired.

The 21 new hulls which were under contract at Cincinnati at the beginning of the year were all delivered.

These hulls were each 68 by 20 by 3½ feet, the cabin 34 by 13 feet and 9 feet high, with a skylight. One of these hulls was used, with the boiler of No. 9, for derrick boat No. 1, and 14 for pile-drivers as follows: Nos. 8, 9, 10, 11, 12, 13, 14, 16, 19, 20, 21, 22, 23, and 24.

Fourteen new boilers were bought for pile-drivers during the year, of which 8 were expended in building pile-drivers Nos. 9, 12, 13, 14, 21, 22, 23, and 24.

These boilers were each 18 feet by 36 inches, with two 13-inch flues.

These pile-drivers were also equipped with Mundy hoisting engines and Gordon force pumps.

The other 6 boilers are 14 feet by 42 inches, with 4 flues, each 10¼ inches diameter, and are designed to replace the boilers retired from drivers Nos. 1 to 6.

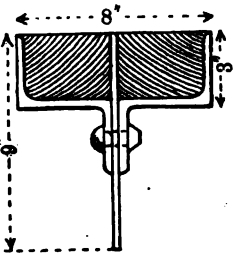
The hoisting engines have two 7½-inch by 10-inch cylinders, a 14-inch drum with wood frictions, foot brake, and 3 independent winch heads.

The pumps have 10 by 10 inch steam and 6 by 10 inch water cylinders with a 5-inch supply pipe.

The 5 pairs of steel leads prepared for setting up during the spring of 1893 were used on drivers Nos. 8, 11, 17, 20, and 22. They were 42 feet high, of 3-inch by ¼-inch Z-bars, with a 9-inch by ¼-inch plate between them riveted together, thus:

The lined space being filled with yellow pine.

The pair built the previous year on No. 17 were put together without the 9-inch web plate and were so badly bent by the hammer that they were taken down and replaced by a pair with the web.



Seven other pairs were also riveted and set up on drivers Nos. 9, 12, 13, 14, 21, 23, and 24, all with side braces of 3½-inch gas pipe and rear braces of 7-inch by ¼-inch channel beams, while the platforms are supported by 3 by 4 inch angle irons.

These leads were also stiffened by yokes of 12-inch by ¼-inch iron riveted to the leads on each of the 3 lower platforms.

The effective plant was increased during the year by the purchase of 11 new pile-drivers, numbered, consecutively, from 25 to 35. These were built by contract in St. Louis and delivered early in January, 1894. They were outfitted and prepared for service at the engineer depot during January and February. These drivers are similar to those fitted up at the engineer depot during the year, except that the jet pump is a Hooker No. 12.

The condition of the drivers at present is as follows:

Six (Nos. 1 to 6) dismantled.

Three (Nos. 10, 16, 19), old machinery moved to new hulls, but not complete.

Three (Nos. 7, 15, 18), old machinery, wooden leads on hulls, built in 1891.

One (No. 17), old machinery, steel leads on hull, built in 1891.

Three (Nos. 8, 11, 20), old machinery, steel leads on new hulls.

Eight (Nos. 9, 12, 13, 14, 21, 22, 23, and 24), with new hulls, steel leads, Mundy hoisting engines, and Gordon jet pumps.

Eleven (Nos. 25 to 35), same as the above, but with Hooker pumps.

This list shows 26 drivers available for service, which will be increased to 35 by using the hulls and machinery now on hand.

Derrick boats.—The hull of derrick boat No. 1 was retired and replaced with one of the new hulls built for pile-drivers, and the boiler, which was that of pile-driver No. 5, was replaced by that taken from No. 9.

Derrick boat No. 2 was built during the winter, the hull of pile-driver No. 4, built in the spring of 1891, being docked and repaired during the winter for that purpose. It has a double-drum Crook hoisting engine with two 7 by 10 inch cylinders, the boiler from pile-driver No. 13, and a derrick 48 feet high, set up with sheer and stiff legs of 5-inch gas pipe, and a boom 42 feet long of two 7-inch channel beams.

Barges.—Two out of the 6 model barges built under contract by Clements Bros., of Paducah, Ky., were received during June of last year, and the other 4, Nos. 116 to 119, were received during the summer.

There were also received during the fiscal year 7 barges, Nos. 120 to 126, built by Coffin & Son at Cincinnati, Ohio.

Six barges, Nos. 127 to 132, built by D. S. Barmore, at Madison, Ind., and 6 barges, Nos. 133 to 138, built by the Howards at Jeffersonville, Ind. These barges are all 135 feet long, 28 feet wide, 5 feet deep, built full model. They were all equipped at the engineer depot with iron pumps and overflow pipes.

Quarter boats.—Quarter boats Nos 1 to 6 were received from Cincinnati during the first half year.

These were all 135 feet long, 30 feet wide, and 3 feet 11 inches deep, with cabins 105 feet long, 24 feet wide, and two stories high, furnishing quarters for 144 laborers besides 26 foremen and kitchen crew.

They were equipped with iron pumps, cross bulkheads, lockers, coal bors, and hatch hoods. Nos. 1, 2, and 3 were supplied with the necessary outfit and sent out for service in the fall, but Nos. 4, 5, and 6 were not outfitted until March, 1894.

Four more quarter boats of the same size (Nos. 7 to 10) were received during the spring from the Howards at Jeffersonville and were supplied with iron pumps, but had not been put into service at the end of the year.

Office and survey boats.—Three office and survey boats, Nos. 1, 2, and 3, built by the Diamond Jo Line Steamers Company at Dubuque, Iowa, were received at the engineer depot during August and September.

They are 135 feet long, 26 feet wide, and 3½ feet deep, with a cabin 109 feet long and 9½ feet high. They were provided with pumps, hatch hoods, lockers, etc., and sent out for service in September.

Quarter barges.—Quarter barges, Nos. 25, 26, and 27, were pulled out on the ways at the depot in December. Nos. 25 and 26 were repaired during the winter and launched in March, but No. 27 had not been calked at the close of the year.

The work done upon these barges consisted in renewing the top sides, stems, chocks, nosing, and plank-sheer.

Machine shop.—The machine shop was supplied during the year with a 20-inch drill press and a machine cutting and threading pipe from 1 to 4 inches in diameter.

Small boats.—The plant was increased during the year by the purchase of 229 flats. Of this number 179 were decked flats 40 feet long, 16 feet wide, and 2½ feet deep. Forty were decked flats 35 feet long, 10 feet wide, and 23 inches deep, and the other 10 of the same size, without decks.

Twenty-eight of the large flats were equipped with ways for building mattresses, and 16 of these with Providence power capstans, size A.

Thirty new skiffs and 10 yawls purchased during the spring were painted.

Derricks.—A derrick 50 feet high for the quarry was prepared for setting up, and a fire-bed boiler put together ready for use and shipped to Ste. Genevieve.

Tools and appliances.—Tools and appliances were constructed as required, including 25 truck and 36 stone boxes for use at the quarry.

Boarding outfit.—This outfit was increased during the year by the construction of 5 ice chests, 2 large ice boxes, 25 by 9 by 7 feet, built on pile-driver hulls, 58 laundry boxes, 65 mess tables, 114 benches, and 50 meat boxes.

Engineer depot.—The value of grounds and buildings at the depot was increased by the following work done under contract during the fall. The Arsenal street water main, which terminated at the Iron Mountain Railroad, was extended down through the yard to within 150 feet of its lower end, a distance of 870 feet. The main used for this extension was 6 inches diameter, with 3 fire plugs so located that a stream of water can be thrown over any building in the yard with 100 feet of hose, which, with a nozzle attached, is kept coupled to each plug.

The fence on the west side of the yard was covered with corrugated iron, No. 20 gauge, and No. 27 gauge was used to cover the west sides and ends of all the permanent buildings near the railroad.

Ways.—Ways for pulling out plant were built during the fall, the bank being graded for this purpose for a distance of 140 feet, beginning about 160 feet below the platform.

The slope adopted was about 1 on 4, and the dirt was removed by scrapers to the depression next the wall, which was filled to a 34-foot stage.

The way pieces were of 8 by 8 inches yellow pine, 12 feet apart, on posts set 4 feet deep and 6 feet apart. The way pieces extended from a 32-foot stage to 4 feet below the low water of 1863, a distance of 174 feet.

Tilting tables were also put in at the top of the bank, and north and south ways 12 feet apart from within 30 feet of the platform to within 50 feet of the lower end of the yard.

The ways were used for docking 2 steam tenders, 3 quarter barges, the machine boat, derrick boat No. 2, and 2 pile-driver hulls.

ORDINARY REPAIRS.

Towboats.—Small repairs were made upon both towboats during the year.

The guards and outriggers of the steamer *General Gillmore* were calked during the fall and new swinging fenders hung during the spring.

The pilot house and furnace of the steamer *General Casey* were repaired.

Steam tenders.—The roofs, wheels, and boiler tubes of tenders Nos. 1 and 2 were renewed during the fall and a set of rocking grate bars put in the furnace of each. They were docked in the fall and were calked and painted before launching in the spring.

The top sides of Nos. 3 and 4 were calked and painted in the spring, and their wheels repaired.

Pile-drivers.—The top sides of all the pile-drivers available for service at the beginning of the season (25 in number) were calked. The leads of pile-driver No. 28 were straightened and the side braces renewed.

Barges.—The top sides of barges Nos. 2, 6, 8, 11, 101, 114, and 122 were calked in the fall and all the barges available for service (46 in number) in the spring. These are numbered as follows:

Eight, Nos. 2, 6, 7, 8, 29, and 30, built in 1885.
Thirteen, Nos. 101 to 113, built in 1891.
Thirteen, Nos. 114 to 126, built in 1893.
Twelve, Nos. 127 to 128, built in 1893.

Quarter boats.—The rakes of quarter boats Nos. 1 to 10 were calked at the winter harbor during the month of March.

Office and survey boats.—The rakes of office and survey boats Nos. 1, 2, and 3 were calked at the winter harbor during the month of March.

Quarter barges.—The quarters on barges Nos. 17, 18, 19, 21, 22, and 24 were removed and the barges retired from service, the office and quarters on Nos. 17 and 19 were set up on Nos. 9 and 29, those on No. 21 were left at St. Genevieve quarry, the kitchen and quarters on No. 18 were set up on the bank at the depot, while the old quarter-boat cabins on Nos. 22 and 24 were removed to barges Nos. 11 and 28. The top sides of all the barges carrying quarters (8 in number), Nos. 1, 3, 4, 5, 9, 11, 28, and 29, were calked in the spring.

Machine shop.—The machine shop was pulled out upon the ways at the engineer depot in the fall, remained out all winter, and was calked thoroughly in the spring.

Small boats.—A pair of temporary ways were put in on the bank and 181 flats were pulled out and blocked up in November. Eighty-four of these flats were calked and launched during the spring.

The rakes of 49 flats were also calked while in the river.

Of the 107 flats now on the bank at this place, 26 have been retired on account of age.

Twenty-three yawls and 40 skiffs were pulled out upon the bank during the fall. Thirteen of the yawls and all of the skiffs were calked and launched in the spring.

Ten skiffs were also repaired during the year by renewing one or both sides.

Tools and appliances and boarding outfit were repaired and kept in serviceable condition.

Portable buildings.—Small repairs and alterations were made upon portable buildings when required.

A shanty of 6¼ sections was set up and repaired under the wall at the depot for storing boarding outfit.

Engineer depot.—A barbed-wire fence was built from the wall to the river at both ends of the yard.

The blacksmith shop and both warehouses were repaired and supplied with large sash.

The shipping platform was extended about 60 feet during the fall for greater convenience in shipping.

Four clumps, of 3 piles each, were driven for moorings along the river front.

Coal.—Three large flats containing about 41,000 bushels of coal were unloaded upon United States barges during May and June.

Clevises.—Clevises were fabricated as required upon the works of construction, 854 being made during the year. A large number were also purchased when they were required faster than they could be made here.

Material of all kinds and subsistence stores were received and shipped as required.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

DETAIL CONSTRUCTION ACCOUNT.

Cost of works at Horsetail, Carrolls Island, Twin Hollows (east and west), Pulltight, Chesley Island, Rush Tower, and Fort Chartres during fiscal year ending June 30, 1894.

Labor, plant, and material.	Hurdles.	Protection.	Total.
Labor, superintendence, etc	$117,322.36	$18,283.01	$135,605.37
U. S. Engineer Office	10,402.92	1,386.21	11,789.13
General expense	9,126.68	1,002.69	10,129.37
Surveys	7,743.79	2,056.88	9,800.67
Care of plant	11,557.91	637.98	12,195.89
Care of material	1,882.66	236.31	2,118.97
Steamer Gen. Gillmore	2,498.02	770.50	3,268.52
Steamer Gen. T. L. Casey	3,163.43	.....	3,163.43
Steam tenders	3,087.48	245.75	3,333.23
Quarter barges	4,254.80	642.51	4,897.31
Quarter boats	1,725.81	48.51	1,774.32
Office and survey boats	1,161.87	39.69	1,201.56
Pile-drivers	13,041.53	493.68	13,535.21
Small boats	18,046.22	616.57	18,662.79
Portable quarters	1,640.28	365.04	2,005.32
Supply depot	2,064.87	324.42	2,389.29
Ways (supply depot)	335.50	104.65	440.15
Machine shop	261.69	81.58	343.27
Tools and appliances	2,967.68	395.76	3,363.44
Boarding outfit	4,013.53	384.26	4,397.79
Office furniture	82.33	10.96	93.29
Subsistence	37,517.29	4,409.65	41,926.94
Brush	36,431.71	6,446.71	42,878.42
Piles	57,774.16	.....	57,774.16
Stone	62,254.52	29,542.96	91,797.48
Rope	2,351.00	217.00	2,568.00
Wire	3,080.64	431.67	3,512.31
Iron	33.94	.....	33.94
Nails	496.62	71.50	568.12
Spikes	1,150.49	106.00	1,256.49
Bolts	666.58	.....	666.58
Clevises	1,098.80	.....	1,098.80
Lumber	301.39	20.00	321.39
Oakum	11.72	1.30	13.02
Coal	7,077.06	352.80	7,429.86
Coal, blacksmith's	2.99	.....	2.99
Ice	3,134.44	561.33	3,695.77
Miscellaneous material	1,879.39	120.71	2,000.10
Total	431,644.10	70,408.59	502,052.69

Distributed as follows:

Locality.	Hurdles.		Protection.		Total.
	Lineal feet.	Amount.	Square feet.	Amount.	
Horsetail	4,340	$69,613.60	372,000	$20,348.40	$89,962.00
Carrolls Island	2,260	36,250.40	.....	.....	36,250.40
Twin Hollows, west side	2,900	46,516.00	305,859	16,730.49	63,246.49
Twin Hollows, east side	.....	.....	9,420	515.27	515.27
Pulltight	7,470	119,816.80	33,240	1,818.23	121,637.03
Chesley Island	.....	.....	65,125	3,562.33	3,562.33
Rush Tower	400	6,416.00	293,640	16,062.11	22,478.11
Fort Chartres	9,550	153,029.30	208,770	11,371.76	164,401.06
Total	26,920	431,644.10	1,288,054	70,408.59	502,052.69

Construction account, showing cost of work to June 30, 1894.

Name of work.	Expended.		Total cost to June 30, 1894.
	Prior to July 1, 1893.	During fiscal year ending June 30, 1894.	
otection	$96,803.63		$96,803.63
	36,341.85		36,341.85
r	145,048.94		144,048.94
protection	42,599.06		42,599.06
Chute	119,958.21		119,958.21
e St. Louis	58,455.54		58,455.54
ikes 1 to 5 inclusive	225,066.31		225,066.31
raining wall	81,253.28		81,253.28
urdles	548,834.08	$69,613.60	618,447.68
ank protection	40,993.55	20,348.40	61,341.95
hurdles	4,093.58	36,250.40	40,343.98
west side, hurdles	269,095.64	46,516.00	315,611.64
west side, bank protection	31,370.55	16,730.49	48,101.04
ast side, bank protection	128,920.30	515.27	129,435.57
es	394,279.35	119,818.80	514,098.15
protection		1,818.23	1,818.23
primary hurdle	7,166.24		7,166.24
ank protection	84,258.76		84,258.76
hurdles	27,808.61		27,808.61
bank protection	70,354.22	3,562.33	73,916.55
rdles	365,803.33		365,803.33
nk protection	7,569.58		7,569.58
, hurdles	177,964.24		177,964.24
	44,296.02		44,296.02
	128,056.65		128,056.65
rdles	211,851.90	6,416.00	218,267.90
nk protection	66,250.72	16,062.11	82,312.83
am	36,812.86		36,812.86
west side, hurdles	72,854.69	153,029.30	225,883.99
ast side, bank protection	28,475.12	11,371.76	39,846.88
	24,463.85		24,463.85
hurdles	47,171.06		47,171.06
k protection	66,465.62		66,465.62
Dam	5,053.91		5,053.91
bank protection	45,129.40		45,129.40
ike No. 1	65,871.17		65,871.17
ams 1 and 2	66,526.88		66,526.88
urdles	33,436.37		33,436.37
primary hurdles	31,930.18		31,930.18
tection	160,439.82		160,439.82
	4,098,125.07	502,052.69	4,600,177.76

Property account.

ass of property.	Value July 1, 1893.	Purchases, additions, and repairs.	Expenses and deterioration charged to works of improvement.	Value June 30, 1894.
llmore	$10,871.98	$25,650.11	$22,810.20	$13,711.89
L. Casey		36,346.97	11,421.27	24,925.70
	4,582.37	2,039.03	6,621.40	
	10,060.38	12,649.92	2,383.39	20,326.91
	76,684.51	80,475.89	18,402.59	138,697.81
	17,166.81	4,957.98	5,948.16	16,176.63
	1,733.33	51,996.81	2,625.55	51,104.59
y boats		13,686.50	1,360.50	12,326.00
	31,533.55	102,097.35	15,052.15	118,578.75
	1,500.00	4,212.90	839.25	4,873.65
		1,011.50		1,011.50
	12,269.99	69,498.95	20,192.97	61,575.97
rs	7,051.18	2,634.03	3,783.00	5,902.21
	190.75		190.75	
	3,105.50	3,564.04	2,389.29	4,280.25
epot)		4,421.27	836.29	3,584.98
	1,943.60	437.03	790.56	1,590.07
ances	6,734.79	12,685.49	6,076.36	13,343.92
	11,896.96	19,132.33	5,655.26	25,374.03
	51.27	175.50	93.29	533.48
ents	634.08	1,387.40	111.22	1,910.26
pparatus	257.14			257.14
	198,668.19	449,061.00	127,643.45	520,085.74

Material account.

Class of material.	Value.		Expended and charged to works of improvement.	Value on hand June 30, 1894.
	July 1, 1893.	Purchased.		
Subsistence	.....	$58,586.22	$57,100.23	$1,485.99
Brush	.....	45,032.82	42,878.42	2,154.40
Piles	$270.77	58,641.10	58,121.10	790.97
Stone	541.66	92,375.29	91,823.10	1,093.85
Rope	11,250.93	5,594.20	2,740.80	14,104.33
Wire	47.59	3,974.62	3,521.31	500.90
Iron	3,361.46	1,877.84	3,083.33	2,155.97
Nails	542.38	471.83	696.08	318.13
Spikes	442.87	1,873.05	1,363.59	952.33
Bolts, screw	1,297.91	445.91	1,113.95	629.87
Bolts, assorted	37.42	208.78	183.31	62.89
Clevises	.....	1,721.92	1,098.80	623.12
Lumber	1,116.44	8,003.34	6,493.31	2,626.47
Oakum	242.44	1,141.20	753.49	630.15
Coal	.....	20,560.03	17,695.90	2,864.13
Coal, blacksmith's	5.07	313.94	257.64	61.37
Ice	.....	5,250.78	5,250.78	.....
Material miscellaneous	10,581.82	28,723.38	32,240.13	7,065.07
Total	29,738.76	334,816.25	326,415.27	38,139.74

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the years 1890, 1891, 1892, 1893.

Articles.	Receipts.				Shipments.			
	1890.	1891.	1892.	1893.	1890.	1891.	1892.	1893.
Barbed wire ores and metals (pig and manufactured)	*Tons.* 21,782	*Tons.* 13,741	*Tons.* 16,768	*Tons.* 11,357	*Tons.* 3,945	*Tons.* 4,802	*Tons.* 3,574	*Tons.* 7,912
Cement	15,892	18,621	1,238	13,429	.....	.....	.....	.....
Coal and coke	81,565	55,980	85,547	23,180	734	148	10,504	28,874
Cotton (and products)	4,230	2,946	1,462	903	527	38	22	19
Groceries and dairy products	8,262	7,604	18,382	22,868	7,428	9,675	13,919	11,789
Hay, seed, grain, flour, meals, etc	92,914	96,526	76,376	77,709	440,728	377,416	314,836	274,201
Jute	17,347	15,217	14,953	13,392	18,379	15,166	10,040	7,631
Live stock and products	132,940	142,090	159,140	126,510	8,526	6,245	7,000	6
Lumber	284,589	234,817	310,370	304,099	117,806	95,842	138,250	95,699
Merchandise and sundries	3,530	4,110	2,559	5,440	1,739	1,435	2,132	3,210
Vegetables	204	63	12	68	1,379	1,555	1,786	1,513
White lead, oils, etc	60	121	64	181	668	590	631	6,938
Wines and liquors	180	304	329	269	3	18	21	8
Wool	.....	.....	.....	.....	.....	.....	.....	.....
Total	663,730	592,140	687,200	599,405	601,862	512,930	502,215	436,900

Transferred by ferries across the river at St. Louis.

	Tons.
1890	3,052,166
1891	3,268,753
1892	2,760,187
1893	2,829,053

Shipments down the river from landings between St. Louis and Cairo during the years 1890, 1891, 1892, 1893.

Grain, including flour, meals, etc.:

	Tons.
1890	34,267
1891	20,353
1892	18,990
1893	21,294

RECAPITULATION.

	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Receipts and shipments at St. Louis	1,265,592	1,105,070	1,189,415	1,036,305
Transferred by ferries at St. Louis	3,052,166	3,268,753	2,760,187	2,829,053
Shipped from landings between St. Louis and Cairo	34,267	20,353	18,990	21,294
Total	4,352,025	4,394,176	3,968,592	3,886,652

List of steam-power boats that arrived at St. Louis during the year 1893.

Size of boats.	Draft.	Boats.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 6	65	1,042
Between 500 and 1,000 gross tons	4 8	21	1,200
Over 1,000 gross tons	6.7 9.5	14	355
Tonnage and size unknown		17	35
Total		117	2,632

List of barges and scows that arrived at St. Louis during the year 1893.

	Draft.	Barges and scows.	Times arrived.
	Feet.		
Under 500 tons	3.5 to 8	28	133
Between 500 and 1,000 tons	5.2 8	15	43
Over 1,000 tons	5.3 9	64	368
Tonnage and size unknown		164	598
Total		271	1,142

List of steamers and barges permanently and temporarily enrolled at the port of St. Louis on December 31, 1893.

	Vessels.	Gross tonnage.	Net tonnage.
Permanently enrolled:			
Steam (wood)	97	40.274.52	39,646.36
Barges (wood)	84	81,188.01	81,097.17
Steam (iron)	4	1,690.29	1,639.82
Permanently licensed:			
Steam, under 20 tons	7	138.47	99.10
Barges, under 20 tons	3	35.72	35.72
Yachts, under 20 tons	1	5.24	5.24
Grand total	196	123,332.25	122,523.41

X 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

St. Louis Harbor has a length of about 18 miles, being divided into two nearly equal parts by the Eads bridge. The upper portion of the harbor, between this bridge and the northern limits of the city, is about 10 miles in length. About 3 miles above the Eads bridge is the Merchants bridge. The lower portion of the harbor, included between the Eads bridge and River Des Peres, is 8 miles long. A good depth of water and accessible landings exist in this lower part of the harbor, and a sufficient depth is found above the Merchants bridge.

Between the Merchants and Eads bridges, however, there existed middle bars, and also shoals near the Illinois shore, which interfered with navigation.

Appropriations for improvement of St. Louis Harbor had been made as early as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work, done in later years by the United States, consisted in the building of stone and brush dikes generally normal to the direction of the current, in the closing of Cahokia Chute, and protection of the bank in Sawyer Bend.

The river and harbor act of Congress approved September 19, 1890, contained an appropriation of $182,000 for improving harbor at St. Louis, Mo., and the officer in charge, in submitting a project for its expenditure, recommended that the money be applied to the portion of the harbor between the Eads and Merchants bridges The approved project consisted in the contraction of the river by a system of hurdles along the Illinois shore for a distance of 13,000 feet to a width of 2,000 feet, with a view to removing the bars which then existed and which interfered with navigation at low stages of the river, and also to improve the ferry landings on the Illinois shore. The object of the hurdles was to cause deposits of sediment, and thus build up a new bank out to the line desired. They were 12 in number, and spaced 1,000 feet apart. The hurdles were from 325 to 2,075 feet in length, each, and were constructed as follows:

The piles were driven in two rows 20 to 27 feet apart, the distance varying with the depth of water. The upper or drift row was composed of three pile clumps spaced 12 feet apart with a stringer bolted to them on the downstream side. The piles in the lower or hurdle row were driven 6 feet apart with a stringer bolted to them on the upstream side. Brace piles for this row were driven every 12 feet with their tops bolted to the stringer. The river ends of the hurdles were further strengthened by cross stringers bolted to the stringers of each row.

The drift row was carried to the 25 and the hurdle to the 20 foot stage above low water at St. Louis, rising, however, with the river above the 20-foot stage. For a length of 1,900 feet at the shore ends of Nos. 1, 9, 10, and 11 only the hurdle row was driven, the depth of water not requiring the drift row.

The woven foundation mattress of willows was 65 feet in width, extending that distance below the drift row by which it was supported during construction. It was placed before the hurdle row was driven. Mattresses 200 feet long by 80 in width were placed at each end of the hurdles for protection against scour. Riprap was also used at the shore ends. Wattling the hurdle row with willows and sinking the drift wood where collected completed the construction of the hurdles.

The hurdles, which were built in depths of 2 feet to 36 feet of water, were all completed by July 1, 1892. The extent of accretion produced by them may be judged by the following:

Soundings taken June, 1892, showed a fill of 8 feet by a width of 400 feet at No. 1 hurdle, 15 feet by a width of 600 feet at No. 6 hurdle, 10 feet by a width of 600 feet at No. 11 hurdle, or an average of about 12 feet over an area of about 160 acres. The filling has increased yearly; by December, 1893, it covered the outer half of the areas inclosed by the hurdles; the depth of fill at No. 1 was 10 feet; at No. 11, 15 feet; between hurdles 6 and 7 it was 26 feet. The areas near to the original shore line have also been filled, but not to such an extent as have the outer areas.

ıe navigable depth in the channel of the harbor betwen the hurdles the opposite wharf line of St. Louis was, in December, 1893, 11 when the river stood at zero on the gauge, and which stage is 4 below standard low water.

mount expended to July 1, 1892, $150,530.21.

he sum of $231.82 was expended during the past fiscal year for vey of the channel.

Io further appropriation is needed for this work.

Vith the balance ($31,007.93) remaining from the appropriation of 0 it is proposed to repair damage that may occur to the hurdles m ice and drift and to extend them whenever found necessary to so.

The commercial statistics will be found in the report on improvent of the Mississippi River between the Ohio and Missouri rivers.

Appropriation made by Congress for improvement of harbor at St. Louis, Mo.

r act of September 19, 1890 ..... $182,000

Money statement.

uly 1, 1893, balance unexpended	$31,469.79
une 30, 1894, amount expended during fiscal year	231.82
July 1, 1894, balance unexpended	31,237.97
July 1, 1894, outstanding liabilities	230.04
July 1, 1894, balance available	31,007.93

X 4.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The navigation of this stream before its improvement was undertaken by the Government was seriously obstructed by snags, logs, and leaning timber, and at times almost suspended on account of numerous shoal crossings. Snags are liable to be found after every flood, which also carries more or less drift; the latter is apt to be deposited at the shoals or at other points, causing trouble to rafts and steamers.

Improvement by the Government commenced in 1880, and the project which was adopted consisted in the removal of snags and logs from the channels and of leaning timber from the banks of the river, where necessary, and in construction of wing dams and training walls to concentrate the flow of water upon the shoals, and thus increase the depth over them.

The estimated cost of the improvement was $50,000, but as new obstructions are continually forming it will require appropriations from time to time to keep the channel open at low water after the principal work has been done. (Please see p. 1740, Appendix X to Annual Report, 1892, lines 21–24 from top of page.)

The amount expended on the improvement to July 1, 1893, was $47,639.40, which resulted in quite generally freeing the river of obstructions from its mouth to Arlington, a distance of 116 miles.

At the beginning of the fiscal year a small party was engaged in removing obstructions at Pryors Bend, which is about 30 miles above the mouth of the river. From Pryors Bend the work of improvement was continued up the river to Arlington.

On August 26, all snags and overhanging trees which obstructed na gation between Arlington and the mouth having been removed, w closed for the season.

The work was done by hired labor.

A crab, operated by a team of horses, was employed in pulling sna Overhanging trees were felled and cut into short lengths.

The number of obstructions removed during the year is as follow

Snags	
Rocks	
Overhanging trees	
Stumps grubbed out	
Stumps cut off	
Total	1,0

The amount expended during the fiscal year was $2,018.95, resultin in further benefit to navigation.

The details of the work are given in the report, herewith, of Mr. J W. Beaman, assistant engineer.

The balance of funds remaining from the appropriations is too smal with which to perform any work of consequence, but it is proposed to apply it to further removal of obstructions, or to repair, where needed existing dams, so far as the money will go.

It is reported that the most troublesome obstruction at present, a low-water, is Baker Shoal, about 6 miles above the mouth of the river This shoal will receive attention this season, and possibly it may b considered advisable to apply part of the next appropriation towar its removal.

The sum of $10,000 can be profitably expended during the fiscal yea ending June 30, 1896, in continuing removal of obstructions and i building wing dams.

The commerce of the river is given in comparative tables of statistic herewith, and to which attention is invited.

Appropriations made by Congress for improving Gasconade River, Missouri.

By act of—	
June 14, 1880	$5,00
March 3, 1881	10,00
August 2, 1882	10,00
July 5, 1884	5,00
August 5, 1886	7,50
August 11, 1888	5,00
September 19, 1890	4,0
July 13, 1892	4,0
Total	50,5

Money statement.

July 1, 1893, balance unexpended	$2,860.
June 30, 1894, amount expended during fiscal year	2,018.
July 1, 1894, balance unexpended	841.
July 1, 1894, outstanding liabilities	13.
July 1, 1894, balance available	829.
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1894.*

MAJOR: I have the honor to submit the following report upon the improvement of the Gasconade River, Missouri, for the fiscal year ending June 30, 1894:

In accordance with your letter of instructions of April 28, 1893, and subsequent instructions, a snagging party was engaged in the removal of obstructions to river navigation in the vicinity of Pryors Mill and Bend on July 1, 1893.

From that point the work of river improvement was continued up the river 86 miles to Arlington, on the San Francisco Railway.

On August 16 the party returned down the river, removing such channel and bank obstructions as had not been removed on the up trip.

On August 26, all snags and overhanging trees obstructing navigation between Arlington and the mouth of the river, a distance of 116 miles, having been removed, the party was disbanded and the property was stored at Bocks Bar warehouse, and left in charge of a watchman.

Since August 26 no field work of any kind has been done on the Gasconade River.

The following is a summary of the work done upon the Gasconade River between the dates July 1 and August 26, inclusive:

Snags removed from the channel	112
Rocks removed from the channel	2
Overhanging trees felled and cut into 16-foot lengths	892
Stumps grubbed out	3
Stumps cut off	3
Total number of miles of river improved from mouth up	116

In the prosecution of the above improvement work there were employed a master laborer, five laborers, and a teamster who furnished a team of horses.

The outfit provided for the party consisted of five skiffs, a crab, blocks, ropes, axes, tents, etc.

The power to work the crab was obtained from a team of horses hired for the purpose.

An examination of the several structures built as contraction works during the previous seven years, made between the dates August 23 to 26, inclusive, developed the fact that they were all in excellent condition and admirably serving the purpose for which they had been constructed.

As soon after July 1, 1894, as the conditions are favorable, a party consisting of a foreman, seven laborers, and a teamster, should be organized to remove the accumulations of snags which have lodged in the channel of the river, and to fell such trees on the banks as have become troublesome to navigation since August 26; also to make such repairs to the cross and spur dam at Bocks Bar, the training wall at Round Island, and the cross dams at Peckerwood, Hensleys Shoal, and at the head of Pryors Mill Chute, as the condition of the structures may seem to indicate.

The point on the river at which the most trouble is now experienced at the lower stages of the river is Baker Shoal, 1 mile below Round Island and 6 miles above the mouth of the river. A wing dam running out from the left bank and a rip rap protection opposite such wing dam on the right bank might concentrate the flow of the low-water stream so as to relieve this difficulty without any very extravagant outlay of money.

Other shoals farther up the river can be benefited by contraction works as soon as money is available for such improvement.

The commercial statistics covering the calendar year 1893, and indicating a commerce by steamboat and raft of 22,058.2 tons, were duly compiled and transmitted April 21.

This indicates a commercial condition of the river very much better than during 1892.

Such provision for its future protection should be made as its value warrants.

In conclusion it may be stated that the work of the year has most materially benefited navigation, especially at Pryors Bend, which has been and will be a point most troublesome.

Very respectfully,

J. W. BEAMAN,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS, GASCONADE RIVER, MISSOURI.

Articles.	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Hay, grain, seeds, etc	2,658	4,035	1,547	3,981
Lumber, logs, wood, railway ties, etc	22,806	19,646	10,626	17,915
Live stock	209	425	416	144
Produce	5	67	80	135
Salt	28	29	23	80
Iron, nails, etc	23	3	4	35
Farm machinery	115	37	30	107
General merchandise	239	216	203	561
Total	26,083	24,458	12,929	23,058

List of steam-power boats engaged in commerce on the Gasconade River during the year 1893.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Gasconade	107	22	3.3	74
Mill Boy	95	18	2.5	70
Pin Oak	95	17.5	2.2	43.05
Royal	86.6	24	3	44.82
Jumbo (gasoline)	57.5	16	2.75	25

X 5.

IMPROVEMENT OF OSAGE RIVER, MISSOURI.

The project for improvement of this stream, adopted in 1871, has consisted in the removal of obstructions to navigation, as snags and leaning timber, and in deepening channels over shoals by means of dredging, and the construction of cross and wing dams to concentrate the water over the shoal places.

The original estimated cost of the project was $230,000, but after that project was adopted the extent of river for which appropriations were made covered more ground than was originally considered, and for a number of years past no estimate of cost of the improvement by removal of snags, shoals, etc., appears to have been rendered in annual reports.

The first efforts at improvement after the General Government assumed charge in 1871 were expended in dredging on the shoals. After this the method pursued consisted in the construction of dams and training walls and removal of snags, leaning timber, etc.

The construction of a lock and dam near the mouth of the river was authorized by the river and harbor act of September 19, 1890. The estimated cost of the lock and dam, as given in the Annual Report for 1892, is $200,000.

An improvement of a portion of the river was undertaken by the State of Missouri a number of years before the General Government assumed charge in 1871. This improvement consisted of wing dams built out from the banks to concentrate the flow of water in a narrow channel with a view to securing an increase of depth through scour. These dams, however, were not kept in repair, and they did not secure the results desired.

Before improvement of the river was undertaken by the Government the channels were so obstructed by snags, trees, and shoals as to make navigation precarious at high stages of water and almost impossible in some portions of the river at low-water stage.

Every high stage of water carries more or less snags into the channel, besides causing scour of banks, resulting in obstructions which have to be removed.

The amount expended by the General Government upon the improvement to June 30, 1893, was $215,573.50. It resulted in benefiting navigation on the river, through removal of snags, leaning trees, shoals, etc., from its mouth to Osceola, Mo., a distance of about 230 miles. The lower 60 miles of the river were the most benefited. These improvements are not altogether of a permanent nature on account of formation of new snags and other obstructions after floods.

The work of the fiscal year ending June 30, 1894, commenced in September last, a party properly equipped and provided with boats moving from the mouth of the river to Mill Shoal, a distance of about 245 miles. Thick ice forming in the pools, it was deemed best for the party to discontinue work at that point and retrace its steps. This was done, but by the time the party arrived at Davis Island the intense cold prevented further movement down the river, and the skiffs and outfit were shipped by rail to Osage City, where they arrived on the 7th of December.

The obstructions removed were as follows:

Snags removed from the channel	218
Rocks removed from the channel	21
Overhanging trees felled	318
Drift trees cut up	267
Stumps grubbed out	38
Stumps cut off	9
Total	871

This work was done by hired labor.

The snags were removed by means of a capstan.

The amount expended during the fiscal year was $3,639.25. The result of the work was to still further benefit navigation, especially during the low-water season, affording a ruling depth at low water of probably 2 to 3 feet.

In addition to the foregoing work, the four gauges from Osage City to Tuscumbia were read daily and their zeros were connected by a line of levels.

The details of the work are given in the report, herewith, of Mr. J. W. Beaman, assistant engineer on the work of removing snags, trees, etc.

Condemnation proceedings for the land on both sides of the river required for the proposed lock at Brennekes Shoal were brought to a close in January, 1894, and the sum of $323.85 was paid to the clerk of the U. S. circuit court at Jefferson City.

During the month of June, 1894, an examination, including borings at the site of the proposed lock, was commenced by Mr. Theo. Schoonmaker, assistant engineer on the construction of the lock. The examination is for the purpose of obtaining data from which to make a complete estimate of the cost of the structure.

With the balance, $5,870.35, from the sum allotted for snagging, etc. (the sum allotted was $10,000 from the appropriation of 1892), it is proposed to further remove such obstructions so far as the money will go.

The sum of $65,000 can be profitably expended during the fiscal year ending June 30, 1896. Of this, the sum of $10,000 is estimated for removing obstructions and building wing dams and training walls where necessary, and $55,000 toward construction of the lock and dam, it not having been considered desirable to undertake the lock construction until $140,000 were available for it.

A table of commercial statistics, to which attention is respectfully invited, is hereto appended.

Appropriations made by Congress for improving Osage River, Missouri.

By act of—		By act of—	
March 3, 1871	$25,000	March 3, 1881	$20,000
June 10, 1872	25,000	August 5, 1886	10,000
March 3, 1873	25,000	August 11, 1888	5,000
June 23, 1874	25,000	September 19, 1890	55,000
June 18, 1878	20,000	July 13, 1892	50,000
March 2, 1879	20,000		
June 14, 1880	30,000	Total	310,000

Money statement.

July 1, 1893, balance unexpended	$94,426.50
June 30, 1894, amount expended during fiscal year	3,639.25
July 1, 1894, balance unexpended	90,787.25
July 1, 1894, outstanding liabilities	744.22
July 1, 1894, balance available	90,043.03
Amount (estimated) required for completion of lock and dam	110,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	65,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1894.*

MAJOR: I have the honor to submit the following report upon the improvement of the Osage River, Missouri and Kansas, for the fiscal year ending June 30, 1894.

In accordance with your letter of instructions of August 29, 1893, a party was organized at Bocks Bar, on the Gasconade River, on September 5, for the removal of channel and bank obstructions to navigation on the Osage River, Missouri and Kansas.

The skiffs which had been previously used in the improvement work upon the Gasconade River were transferred by water by way of the Missouri River to the mouth of the Osage River, a distance of 31 miles.

The party then proceeded up the Osage River, removing snags, felling overhanging trees, and making slight repairs to gauges at Brennekes Shoal and Tuscumbia as these points were reached.

On November 24 the work had advanced to Mill Shoal, 245.4 miles above the mouth of the river.

On account of thick ice forming on the pools it was deemed advisable to discontinue work at this point and return.

On the return trip, begun November 25, overhanging trees between Warsaw and Osceola, which had been left on the up trip, were felled, and the party arrived at Davis Island December 2.

At this point the intense cold of the night of December 3 practically closed navigation.

On December 4 an effort was made to break the ice between Davis Island and Warsaw.

This proved to be impracticable, and the skiffs and outfit were transported by wagon to the Warsaw Railway depot, a distance of about 4 miles.

In this transfer two days were consumed.

On December 6 the plant was shipped by railway freight from Warsaw to Osage City, arriving at that point in good order December 7.

On December 8 it was transferred by river to the storehouse at Brennekes Shoal.

After it had been properly stored it was left in charge of a watchman, and the party was disbanded, only the permanent employés being retained.

During the latter part of December the gauges at Tuscumbia, Burds Shoal, and Brennekes Shoal were put in perfect order.

During the month of January no field work was done.

uring the month of February the lines bounding the United States reservation rennekes Shoal were rerun, and the corners on the right bank of the river were erly established and marked by oak posts 3 feet by 8 inches by 8 inches, set in the und 2½ feet; similar posts had previously been set up on the left bank.
he gauge at Osage City having been put out of order by ice, drift, and a steam- t collision, it was repaired February 6, and on Febrtary 26 its 0 elevation was rmined by level.
line of levels was also run from Brennekes Shoal to the foot of Rices Island, a ance of about 5 miles, to connect with a line of levels which had previously n run between that point and White Oak Shoal, a point 23 miles above and 36 s from the mouth of the river.
uring the month of March no field work was done.
uring the month of April a line of levels was run from White Oak Shoal to Tus- bia, and from that point return levels were run to White Oak Shoal; distance ween the two points 24 miles.
uring the month of May no field work was done.

* * * * * * *

he field work of the year may be tabulated as follows:

Snagging, etc.

gs removed from the channel	218
cks removed from the channel	21
erhanging trees felled and cut into 16-foot lengths	318
ift trees cut up into 16-foot lengths	267
umps grubbed out	38
umps cut off	9
les of river line improved from mouth up	245.4

Gauges repaired and tested.—Tuscumbia gauge, September 28, December 18; Burds oal gauge, December 21; Brennekes Shoal gauge, September 9, December 28; age City gauge, February 6, 26.
Transit and level surveys made.—Transit resurvey of United States reservation at ennekes Shoal during February as weather permitted. Level survey, Brennekes oal to Rices Island, distance 5 miles, during February as weather permitted. Level rvey to determine elevation of 0 of gauge at Osage City above sea level February 26. vel survey, White Oak Shoal to Tuscumbia, distance 24 miles, April 2–25.
In addition to the above, the gauges at Tuscumbia, Burds Shoal, Brennekes Shoal, d Osage City (distant, respectively, from the mouth in miles 60, 22.5, 8, and 1) re duly observed at 8 a. m. daily.
Hydrographs showing the fluctuations of the river since the establishment of the ges at the points below Tuscumbia were duly transmitted May 31.
Force employed, outfit, etc.—The snagging party during most of the season devoted field work consisted of a master laborer, 7 laborers, and a teamster who furnished team of horses.
The outfit provided consisted of five skiffs, a capstan, ropes, blocks, shovels, tents, c. Two skiffs were also furnished by employés, and were used in the transporta- n of the outfit.
Since the 8th of December one man has been employed in the field as leveler, sisted as there was need by a laborer in the work incident to the care of the ges and in the transit and level work.
In addition, a gauge observer was employed in the daily observation of each of the ur gauges—four observers in all.
The work of the year has been in all respects well done, and reflects much credit on all the employés engaged in it, and especially upon Mr. W. P. Pollard, who s acted as foreman and leveler.
By the snagging operations the channel has been rendered navigable by boats d raft, and since work ceased, December 8, no trouble has been experienced on count of snags or overhanging trees obstructing the way. With 3 feet of water the shoals, steamboats, and with 2 feet of water on the shoals, steamboats accom- nied by barge, and with 1 foot of water on the shoals rafts of railway ties easily vigate the river.

IMPROVEMENT WORK FOR NEXT FISCAL YEAR.

The work of the fiscal year beginning July 1, 1894, will involve—
The removal of snags and leaning trees from the highest point on the river ched by steamboat navigation to the mouth, in the vicinity of 250 miles of river e.
The repair of a break in the dam at Round Bottom Shoal, 26.2 miles above the uth of the river. Of this break serious complaint has been made by raftsmen, it tends to draw away much of the channel water, and also the rafts themselves

3. The repair of similar works which may need attention at inconsiderable expense.

A party organized as was the party of the present year can, after the completion of the work on the Gasconade River from the mouth to Arlington, have its outfit shipped from Jerome (the railway station on the left bank of the Gasconade River, and opposite Arlington) to Osceola, and the work of improvement can be prosecuted from the head of navigation to the mouth; commercial statistics can also be gathered by the way at the same time.

With the river free, as it is at present, from channel obstructions below Tuscumbia, the plan proposed will be the best from an economical standpoint.

The commerce of the river, statistics of which for the calendar year 1893 were transmitted on April 21, show a healthful condition, though somewhat less in amount than during the calendar year 1892, and will warrant the expenditure of all the money necessary to keep the river in good navigable condition.

Very respectfully,

J. W. BEAMAN,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers.

COMMERCIAL STATISTICS—OSAGE RIVER, MISSOURI AND KANSAS.

Articles.	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Hay, grain, seeds, etc	5,118	6,135	5,471	3,773
Lumber, logs, wood, railway ties, etc	86,349	77,195	69,721	62,020
Live stock	766	957	739	741
Produce	319	527	182	196
Salt	482	602	281	329
Barytes	1,710	2,775	1,200	470
Iron, nails, etc	408	510	67	7
Farm machinery	453	588	83	20
General merchandise	1,408	1,760	1,536	919
Total	97,013	91,049	79,280	68,475

List of steam-power boats engaged in commerce on the Osage River during the year 1893.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Annie Dell	70	16	2	19.05
Andrew S. Bennett	115	30	3.5	78.06
Black Diamond	72.5	14.4	2.3	18.4
Edna	102	21.5	4.7	83.35
John R. Hugo	127	20	3	126.86

X 6.

IMPROVEMENT OF KASKASKIA RIVER, ILLINOIS.

A survey of this stream from New Athens to its mouth was made in 1887.

The project for improvement, adopted in 1890, consists in deepening the water over the two principal shoals between the mouth of the river and Evansville, viz, at the Nine Mile and the Evansville shoals, and in removing snags and other obstructions from the mouth to the Baldwin bridge, a distance of about 22 miles. Estimated cost of the project, $10,500.

Before work for improvement was undertaken by the Government the stream was practically blocked near its mouth during the low-water season by the Nine Mile Shoal, over which there was often a depth of only 9 inches when the St. Louis gauge read 6.5 feet. In addition, the

navigation was greatly obstructed on account of snags, shoals, and bars.

At high water navigation was possible as far up the stream as New Athens.

The first appropriation for the improvement was $6,000, made by the river and harbor act of September 19, 1890.

During the fall and part of December, 1891, Nine Mile and Evansville shoals were excavated, the former so as to give a channel 75 feet wide and 36 inches deep, and the latter to give a channel 60 feet wide and 34 inches deep, at low water, the excavated material being utilized in constructing dikes, etc., to concentrate the flow of water in the cuts. A number of snags were also removed from the channel.

This work was of great benefit to the commerce of the river.

The river and harbor act of July 13, 1892, appropriated $4,500 for the improvement. Under this appropriation work was resumed in September, 1892, by hired labor, and prosecuted until December 23, when it was suspended on account of cold weather. The work of the season (1892) consisted in removal of snags, trees, rack heaps, logs, and several rocks from the stream between Baldwin bridge and Cox's ferry, thus further improving the navigation.

The work of improvement during the past fiscal year consisted in further removal of obstructions from the channel at Evansville Shoal and Nine Mile Shoal, and from the river between the two shoals, so far as the funds at hand would admit of, the length of river cleared of obstructions being about 8 miles. The dikes constructed at Evansville Shoal in 1891 were also repaired.

The work of the fiscal year began September 6 and continued until the latter part of October. There were remoyed from the channel 170 cubic yards of rock and 51 snags; 55 leaning trees were also removed from the banks. The rock was utilized in repairing the dikes.

The work was done by hired labor.

The result of all the work accomplished to date is that steamboats are enabled to navigate the stream at lower stages and for low-water seasons of greater length than formerly was the case.

For amount of commerce benefited by the work please see table of commercial statistics herewith.

Expended upon the improvement to July 1, 1893	$9,108.11
Expended upon the same during the fiscal year ending June 30, 1894	1,352.69

Appropriations made by Congress for improving Kaskaskia River, Illinois.

By act of—	
September 19, 1890	$6,000
July 13, 1892	4,500
Total	10,500

The amount ($10,500) originally estimated as necessary for the improvement having been appropriated, no further appropriation is here estimated.

Money statement.

July 1, 1893, balance unexpended	$1,391.89
June 30, 1894, amount expended during fiscal year	1,352.69
July 1, 1894, balance unexpended	39.20

COMMERCIAL STATISTICS, KASKASKIA RIVER, ILLINOIS.

[Compiled from information furnished by Mr. Nick Sauer, of Evansville, Ill., and Capt. Harvey Neville, of Chester, Ill.]

Articles.	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Coal	60	400	300	100
Cord wood and lumber	2,105	2,054	3,000	5,475
Flour, grain, etc	5,837	9,186	600	3,280
Merchandise	400	405	500	400
Total	8,402	12,045	4,400	9,255

List of steam-power boats engaged in commerce on the Kaskaskia River, Illinois.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Dolphin	135.8	22.8	4.8	156.16
Little Nick	60	10	3	14.22
Mary M. Michael	143.3	26.3	4.4	234.44
Nick Sauer	100	18	4	99.27
Four barges not named	150	28	5	500

APPENDIX Y.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS, AND OF GALENA RIVER, ILLINOIS.

REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Operating snag boats and dredge boats on Upper Mississippi River.
2. Mississippi River between Missouri River and Minneapolis.
3. Des Moines Rapids, Mississippi River.
4. Operating and care of Des Moines Rapids Canal and Dry Dock.
5. Operating and care of Galena River improvement.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 7, 1894.

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Y 1.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions, the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements and for facilitating navigation through bridges, inspection and repair of works, formation of temporary or permanent channels through obstructing bars, and in general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi River.

The plant belonging to this work consists of the snag boats *General Barnard* and *J. G. Parke*, and to these are added, as occasion demands

and circumstances permit, dredges, launches, barges, etc., belonging to the general appropriations. The operations of the snag boats and dredges extend from Minneapolis to the mouth of the Missouri River, about 724 miles. At times when the snag boats are not required on work above mentioned they are used under general or special appropriations for work of permanent construction.

By the river and harbor act of August 11, 1888, provision was made for operating snag boats and dredge boats on the Upper Mississippi River under a permanent appropriation, the annual expenditure being limited by the act to $25,000. There has been expended under the permanent appropriation during the fiscal year ending June 30, 1894, the sum of $25,000.

The snag boat *General Barnard* was engaged in the work of removing snags, etc., July 1 and 2. July 10 to October 28, 1893, and from April 5 to June 30, 1894.

The snag boat *J. G. Parke* was loaned during the year to the general improvement, and was employed on construction work.

The details of work accomplished, together with the statistics of commerce and navigation, are given in the appended report of Assistant Engineer C. W. Durham.

A detailed statement and a summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1894, are appended.

The total tonnage of the Mississippi River between the Falls of St. Anthony and mouth of Missouri River for calendar 1893 was approximately 3,200,000. This includes logs and lumber as well as ordinary merchandise.

Abstract of appropriations.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved—	
July 11, 1870	36,000
March 3, 1871	42,000
June 10, 1872	42,000
March 3, 1873	25,000
June 23, 1874	25,000
March 3, 1875	25,000
August 14, 1876	30,000
June 18, 1878	41,500
March 3, 1879	20,000
June 14, 1880	8,000
March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	25,000
June 30, 1890	25,000
June 30, 1891	25,000
June 30, 1892	25,000
June 30, 1893	25,000
June 30, 1894	25,000
Total	674,640

Money statement.

June 30, 1894, amount drawn from Treasury under permanent appropriation	$25,000.00
June 30, 1894, amount expended during fiscal year	25,000.00
July 1, 1894, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1895	25,000.00

tement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1894.

To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
July, 1893.							
arham	$4.25	$4.25					
	3.75	3.75					
al	8.00	8.00					
August, 1893.							
en	1,323.17		$1,323.17				
	90.00		90.00				
Fidlar & Chambers	4.50	4.50					
r	8.21			$7.91		$0.30	
ogum	9.66			9.66			
llwell Meat Co	6.50			6.50			
dington	8.55			8.55			
ons	6.12			6.12			
Bros	6.64			6.64			
t	19.80			19.80			
y & Son	6.05			6.05			
ams	19.74			19.74			
. Koettker	19.05			19.05			
. Weess	5.25			5.25			
Schindler & Co	11.30			11.30			
d Jo Line Steamers	17.10				$17.10		
nt	7.50				7.50		
ppi Coal and Ice Co	4.66				4.66		
r Iron Works Co	8.08					8.08	
	3.31					3.31	
d Oil Co	6.15					6.15	
nt	69.00				69.00		
ight	50.60				50.60		
ethan	36.00				36.00		
Frick	27.00				27.00		
nsolidated Coal Co. of nis	107.25				107.25		
Coal Co	45.00				45.00		
rnett	103.50				103.50		
d V. Coal Co	34.50				34.50		
lley Mining Co	85.64				85.64		
	90.00				90.00		
. Buncher	27.14			26.29		.85	
ecke-Miller Co	200.22			193.69		6.53	
. Schindler & Co	35.87			35.87			
Long	34.20			21.70	12.50		
hert & Co	35.03			35.03			
Bros	16.92			16.92			
ow Bros	16.28			16.28			
Ward & Son	170.84			17.12		153.72	
d Oil Co	40.80					40.80	
elshymer	69.42					69.42	
& Cherry Co	2.40						$2.40
artin	10.00				10.00		
ser & Son	1.00					1.00	
ot Steamboat Co	63.00				63.00		
onkling	3.60			3.60			
urham	10.00	10.00					
	3.25	3.25					
. Schindler & Co	87.69			87.69			
. Long	45.83			40.33		6.50	
ow Bros	18.47			16.92		1.55	
oberton	9.45			9.20		.25	
ume	12.80			12.80			
s Bros. & Schwab	37.24			37.24			
rogum	22.48			22.48			
rnett	92.00				92.00		
unt	23.00				23.00		
Richtman	62.50				62.50		
ros	4.50				4.50		
d Jo Line Steamers	61.20				61.20		
'Neil	18.00				18.00		
rginia	22.00				22.00		
right	34.50				34.50		
lley Mining Co	171.00				171.00		
nen	1,422.67		1,422.67				
ot Steamboat Co	100.00					100.00	
tal	5,226.13	17.75	2,835.84	719.73	1,251.95	398.46	2.40

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	September, 1895.							
1	W. R. Tibbals	$125.00		$125.00				
2	C. W. Durham	7.00	$7.00					
3	The Consolidated Coal Co. of St. Louis	102.50				$102.50		
4	A. Boschert & Co	89.19			$89.19			
5	James Ward & Son	88.74			32.81		$41.80	$14.13
6	King & Frick	45.00				45.00		
7	Henry A. Koettker	20.05			20.05			
8	The W. A. Bonsack Lumber Co.	49.89						49.89
9	Anton Brink	10.00				10.00		
10	L. T. Biethan	85.50				85.50		
11	A. J. Stillwell Meat Co	17.63			17.63			
12	Conrad Bros	34.86			34.86			
13	Henry Meloan	10.56			10.56			
14	T. Nodler	21.40			21.40			
15	Mississippi Coal and Ice Co	9.00				9.00		
16	The Kratka Towing Co	20.00				20.00		
17	Standard Oil Co	5.25					5.25	
	Total	721.57	7.00	125.00	206.50	272.00	47.05	64.02
	October, 1895.							
1	Hired men	1,411.00		1,411.00				
2	....de	41.00		41.00				
3	C. W. Durham	6.25	6.25					
4	R. S. Owen	36.00				36.00		
5	Buck-Reiner Co	76.61			70.91		5.70	
6	T. Nodler	14.82			14.82			
7	Mississippi Coal and Ice Co	2.50						2.50
8	J. W. Caldwell	2.60						2.60
9	James Ward & Son	23.93			5.63		18.30	
10	L. T. Biethan	57.00				57.00		
11	N. H. Phillips	22.50				22.50		
12	Consolidated Coal Co. of St. Louis	48.75				48.75		
13	Henry A. Koettker	11.60			11.60			
14	A. Boschert & Co	20.44			20.44			
15	A. J. Stillwell Meat Co	34.85			34.85			
16	Conrad Bros	29.04			29.04			
17	C. W. Durham	3.75	3.75					
18	Henry Dart's Sons	174.93			164.58		10.35	
19	Ben. Wilson & Son	14.20						14.20
20	King & Frick	27.00				27.00		
21	James McNamara	34.13				34.13		
22	Wm. Andrus	10.24						10.24
23	Wm. H. Pape	12.00				12.00		
24	Quincy Coal Co	18.00				18.00		
25	Jno. O'Neil	54.00				54.00		
26	John Harry	34.50				34.50		
27	C. A. Hunt	40.00				40.00		
28	Fred. Harry	57.50				57.50		
29	F. J. Fugina	35.00				35.00		
30	J. Kieffer	24.00			24.00			
31	Gentzkow Bros	19.78			19.78			
32	C. W. Durham	4.50	4.50					
33	C. J. Long	38.87			34.07		4.80	
34	Thos. E. Schindler & Co	50.76			50.76			
35	York Bros	2.25				2.25		
36	T. C. Bright	151.80				151.80		
37	Gannitz Bros. & Schwab	30.66			3.60	27.06		
38	Furlong Grocery Co	8.22			8.22			
39	Klindt, Geiger & Co	15.25			15.25			
40	J. H. Schrogum	25.10			25.10			
41	Coal Valley Mining Co	120.53				120.53		
42	Hired men	1,465.00		1,465.00				
	Total	4,310.86	14.50	2,917.00	532.65	778.02	39.15	29.54

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	November, 1893.							
1	C. W. Durham	$7.25	$7.25					
2	do	8.90	8.90					
3	F. B. Martin	12.57	12.57					
4	Hired men	102.38						$102.38
5	Conrad Bros.	21.81			$21.81			
6	L. T. Biethan	21.80				$21.80		
7	A. J. Martin	10.00				10.00		
8	R. S. Owen	27.00				27.00		
9	James Ward & Son	19.24			.60		$18.64	
10	C. W. Durham	8.50	8.50					
11	L. T. Biethan	76.00				76.00		
12	Hired men	425.00		$344.00				81.00
13	do	199.50		74.50				125.00
14	John M. Keiflein	58.50				58.50		
15	The W. A. Bonsack Lumber Co.	428.95						428.95
	Total	1,427.40	37.22	418.50	22.41	193.30	18.64	737.33
	December, 1893.							
1	W. R. Tibbals	37.50	37.50					
2	Hired men	319.66						319.66
3	E. Schultz	9.36					9.36	
4	Hired men	480.00	75.00	280.00				125.00
	Total	846.52	112.50	280.00			9.36	444.66
	January, 1894.							
1	C. W. Durham	5.25	5.25					
2	David Tipton	13.25	13.25					
	Total	18.50	18.50					
	February, 1894.							
1	Hired men	690.00	325.00	240.00				125.00
2	do	690.00	325.00	240.00				125.00
	Total	1,380.00	650.00	480.00				250.00
	March, 1894.							
1	C. W. Durham	10.25	10.25					
2	A. Weber Co.	22.22						22.22
3	Taber & Co.	47.29						47.29
4	do	70.35						70.35
5	C. W. Durham	5.25	5.25					
6	Hired men	295.00	37.50	57.50				200.00
7	do	520.51		520.51				
8	F. B. Martin	8.19	8.19					
9	C. W. Durham	13.00	13.00					
10	W. R. Tibbals	6.69	6.69					
	Total	998.75	80.88	578.01				339.86
	April, 1894.							
1	Hired men	16.56						16.56
2	David Tipton	4.80					4.80	
3	St. Louis, Keokuk and Northwestern R. R. Co	35.00					35.00	
4	C. W. Durham	4.50	4.50					
5	do	5.50	5.50					
6	A. Mackenzie, Major of Eng'rs.	30.40	30.40					
7	A. Weber Co.	3.63						3.63
8	do	1.08						1.08
9	T. S. Adams	3.55			3.55			
10	C. W. Durham	2.50	2.50					
11	do	250.00	250.00					
12	Hired men	1,433.50		1,433.50				
13	do	147.00		147.00				
	Total	1,938.02	292.90	1,580.50	3.55		39.80	21.27

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	May, 1894.							
1	A. J. Stillwell Meat Co	$8.00			$8.00			
2	T. E. Schindler & Co	37.27			37.27			
3	Frank J. Weess	33.07			33.07			
4	Henry A. Koettker	35.90			35.90			
5	A. Boschert & Co	61.62			61.62			
6	Conrad Bros	27.00			27.00			
7	T. Nodler	37.74			30.35		$7.39	
8	Chas. J. Long	26.54			16.64		9.90	
9	T. R. J. Ayres & Sons	5.50					5.50	
10	Menasha W. S. Pulley Co	9.76						$9.76
11	W. H. Watters	20.25					20.25	
12	Davis Company	3.46						3.46
13	Wrought Iron Range Co	176.00					176.00	
14	Anchor Line store	441.72			145.52		296.20	
15	Penn Tank Line Co., Limited	21.00					21.00	
16	Standard Oil Co	33.02					33.02	
17	Wilkinson & Co	54.14						54.14
18	S. C. & S. Carter	82.07						82.07
19	Taber & Co	15.69						15.69
20	The W. A. Bonsack Lumber Co.	26.85						26.85
21	L. T. Biethan	36.00				$36.00		
22	John Spies	13.00				13.00		
23	Crown Coal and Tow Co	90.00				90.00		
24	Wm. C. Eileman	24.50				24.50		
25	Quincy Coal Co	24.00				24.00		
26	Gannitz Bros. & Schwab	79.88			22.13	57.75		
27	Diamond Jo Line steamers	54.00				54.00		
28	Coal Valley Mining Co	162.00				162.00		
29	Kellogg-Birge Co	148.13			138.98		9.15	
30	J. H. Scrogum	15.48			15.48			
31	Mississippi Coal and Ice Co	112.97			12.00	48.00	1.54	51.43
32	do	72.00				72.00		
33	George Hill	200.93						200.93
34	A. D. Thomas	239.93						239.93
35	do	27.77						27.77
36	C. W. Durham	6.25	$6.25					
37	do	5.25	5.25					
38	Henry Dart's Sons	181.11			174.81		6.30	
39	Albert Kirchner	11.55			11.55			
40	J. H. Scrogum	15.05			15.05			
41	Gentzkow Bros	10.42			10.42			
42	Klindt, Geiger & Co	14.45			14.45			
43	Gannitz Bros & Schwab	80.50				80.50		
44	John Espenship	50.00				50.00		
45	George Hill	7.75						7.75
46	Gaunitz Bros. & Schwab	77.40			8.40	69.00		
47	Coal Valley Mining Co	306.00				306.00		
48	Levi Boardman	20.00				20.00		
49	J. H. Scrogum	5.70			5.70			
50	Thos. E. Schindler & Co	55.63			55.63			
51	Chas. J. Long	15.10			13.00		2.10	
52	C. W. Durham	3.50	3.50					
53	A. Boschert & Co	39.66			39.66			
54	H. A. Koettker	16.50			16.50			
55	The Consolidated Coal Co. of St. Louis	108.00				108.00		
56	The W. A. Bonsack Lumber Co	40.87						40.87
57	Anchor Line store	2.22					2.22	
58	Standard Oil Co	44.33					44.33	
59	Dan Kerwin	9.50						9.50
60	James Ward & Son	219.58			12.15		207.43	
61	C. W. Durham	250.00	250.00					
62	Hired men	1,550.00		$1,550.00				
	Total	5,603.51	265.00	1,550.00	961.28	1,214.75	842.33	770.15
	June, 1894.							
1	James Ward & Son	8.83			5.68		3.15	
2	Wm. C. Eileman	28.87				28.87		
3	Anton Brink	15.00				15.00		
4	Michael Navarre	5.62				5.62		

Detailed statement of expenditures for operating snag boats, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	June, 1894—Continued.							
5	The Consolidated Coal Co. of St. Louis	$216.00				$216.00		
6	Anton Schulte	20.25				20.25		
7	G. W. Anderson	22.50				22.50		
8	Henry A. Koettker	27.00			$27.00			
9	A. Boschert & Co	42.00			42.00			
10	James Ward & Son	15.45			15.25		$0.20	
11	The Consolidated Coal Co. of St. Louis	175.00				175.50		
12	T. R. J. Ayers & Sons	1.50					1.50	
13	C. J. Long	20.78			17.24		3.54	
14	Thos. E. Schindler & Co	29.60			29.60			
15	Henry Fox	16.00			2.50	13.50		
16	Chas. Bernard	20.00				20.00		
17	H. J. Brown	39.50			1.00	38.50		
18	J. M. York	25.13				25.13		
19	Pie E. Dunn	7.55			6.85		.70	
20	Gaunitz Bros. & Schwab	10.56			10.56			
21	J. H. Scrogum	17.11			17.11			
22	A. S. Aloe Company	4.30					4.30	
23	John Espenship	50.00				50.00		
24	Gentzkow Bros	16.92			16.92			
25	Gustie Bolz	4.95			4.95			
26	J. Kieffer	46.80			46.80			
27	Kenny Bros	11.00						$11.00
28	Furlong Grocery Co	17.27			15.27	2.00		
29	Geo. Lamont	132.75				132.75		
30	C. W. Durham	4.00	$4.00					
31	Hired men	1,383.00		$1,383.00				
32	..... do	85.00		85.00				
	Total	2,520.74	4.00	1,468.00	258.73	765.62	13.39	11.00

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1894.

Months.	Office expenses, superintendence, and contingencies.	Care, repair, and operating snag boats and dredge boats.						Grand total.
		Labor.	Subsistence.	Fuel.	Expense.	Repairs.	Total.	
1893.								
July	$8.00							$8.00
August	17.75	$2,835.84	$719.73	$1,251.95	$398.46	$2.40	$5,208.38	5,226.13
September	7.00	125.00	206.50	272.00	47.05	64.02	714.57	721.57
October	14.50	2,917.00	532.65	778.02	39.15	29.54	4,296.36	4,310.86
November	37.22	418.50	22.41	193.30	18.64	737.33	1,390.18	1,427.40
December	112.50	280.00	.....	.....	9.36	444.06	734.02	846.52
1894.								
January	18.50	.....	.....	.....	.....	.....	.....	18.50
February	650.00	480.00	.....	.....	.....	250.00	730.00	1,380.00
March	80.88	578.01	.....	.....	.....	339.86	917.87	998.75
April	292.90	1,580.50	3.55	.....	39.80	21.27	1,645.12	1,938.02
May	265.00	1,550.00	961.28	1,214.75	842.33	770.15	5,338.51	5,603.51
June	4.00	1,468.00	258.73	765.62	13.39	11.00	2,516.74	2,520.74
Total fiscal year	1,508.25	12,232.85	2,704.85	4,475.64	1,408.18	2,670.23	23,491.75	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1894.

MAJOR: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1894, together with some statistics of commerce and navigation.

Operations of snag boat General Barnard.—On July 1, 1893, the *Barnard* left Rock Island with three construction flats in tow, which were taken to Keokuk and left there on the evening of the 2d. Between Rock Island and Keokuk on this trip snags were removed near Keithsburg, Huron Island, and Oquawka. On July 10 the *Barnard* departed for St. Louis, arriving there on the 11th, and returning, reached Keokuk on the 18th. On this trip snags and other obstructions were removed at or near Nigger Chute, Turtle Island, Saverton, Blackbird Island, Clarksville Chute, Wood River, Maple Island, Piasa Dam, Masons Island, McCanns, Becks, Turners Island, Sandy Island, Stag Island, Westport Chute, Thomas Chute, McCoys Island, Amaranth Island, Fabius Island, and Ortons Island. July 19 to 21 the *Barnard* made an inspection trip from Keokuk to Hannibal and return. On the 22d she left for up river, arriving at Merrimac on August 3, and turning back down river reached Keithsburg August 8. On this trip snags and other obstructions were removed at or near Devils Island, Thompsons Island, Twin Islands, Drews Prairie, Benton Island, Keithsburg, Bay Island, Muscatine, Lyons, Elk River, Arnolds, Nine Mile Island, Hurricane Island, Cassville Slough, Clayton, McGregor, Lynxville, Heytmans, Coon Slough, Brownsville, Picayune Island, Trenton, Diamond Bluff, Trempealeau, and Root River. On the 8th, taking dredge *Phœnix* and three dumps in tow, the *Barnard* proceeded up river, arriving at Chimney Rock on the 22d, having been much delayed by shoal water on several of the crossings. Leaving the tow, the *Barnard* on the 23d left for down river, reaching St. Louis September 3. On this trip obstructions were removed at or near La Crosse, Dubuque, Hershey Chute, Bay Island, Twin Islands, Devils Island, Warsaw, Gregorys, Louisiana, Mundys, Clarksville Chute, and Grimes Island. The *Barnard* was inspected at St. Louis on September 4, and left on the 5th for above, reaching Keokuk on the 15th. On this trip snags and other obstructions were removed at or near Maple Island, Ellis Island, and Elsah. September 16 to 30 the *Barnard* towed dredge *Phœnix*, two dumps, and one flat from Keokuk to Alton, then proceeded to St. Louis, coaled and took on supplies and returned to Keokuk. On the return from St. Louis snags and other obstructions were removed at or near Portage, Masons Island, Mound Landing, Cuivre Island, Stag Island, Clarksville, Turtle Island, Armstrong Island, Whitneys, Fabius Island, and mouth of Des Moines River. On October 1 the *Barnard* proceeded up river with steam-drill boat *No. 6* in tow. Leaving the drill boat at Rock Island she reached St. Paul on the 12th, and turning back down river arrived at Keokuk on October 21. On this trip obstructions were removed at Deadmans, Bellevue, Hershey Chute, Saurweins Bend, and Twin Islands. October 22 to 27 the *Barnard* made a trip from Keokuk to St. Louis and return, removing snags at McCanns and Alton. On October 28 placed sheer boom in the canal and went into the dry dock for hull repairs; came out of the dry dock on November 8 and laid up at fleet above Middle Lock for winter.

In 1894, the *Barnard* having been repainted and having received ordinary repairs, was put in commission April 3. On April 3 and 4 the floating boom connecting the lower lock with the Keokuk bridge was put in position. On the 5th she left Keokuk for below and reached St. Louis on the 7th. Returning up river she arrived at St. Paul May 5. On the up trip snags and other obstructions were removed at or near Maple Island, Missouri Point, Stag Island, Cap au Gris, Carrolls Field, Turners Landing, Hickory Chute, Mundys Landing, Whitneys, Tully Chute, Skunk River, Dark Chute, Apple River, Nine Mile Island, and Cassville Chute. On May 7 the *Barnard* worked between Minneapolis and St. Paul and made an attempt to reach Minneapolis, but failed to do so on account of swift current. On the 8th the *Barnard* left St. Paul and ran to Rock Island, returned to Fountain City and thence to St. Louis, arriving there May 24. On this trip work was performed at or near Grey Cloud, Morgans Coulee, La Crosse, Picayune Island, Crooked Slough, Wyalusing, Harris Slough, Raft Channel, Hershey Chute, Keithsburg, Saurweins, Dallas, Devils Island, Canton, Reds, and Carrolls Field. May 24 to June 6 the *Barnard* worked between St. Louis and Saverton. On June 7 she left St. Louis for up river, reaching St. Paul June 23, and returning down river tied up at Chimney Rock on the evening of June 30. Between May 24 and June 30 snags and other obstructions were removed at or near Chouteau Park, Wood River, Maple Island, Alton Slough, Squaw Island, Hatchet Chute, Iowa Island, Becks Landing, Cuivre Island, Turners, Hamburg, Thomas Chute, Wildwood Landing, Henderson River, Dark Slough, Sand Prairie, Goldens, Maquoketa Slough, Finley Hollow, Hurricane Island, Clayton, Lynxville, De Soto, Coon Slough, Blacksmith Chute, Pap Chute, Redwing, Trenton, and Diamond Bluff.

mary of operations of snag boat General Barnard for fiscal year ending June 30, 1894.

gs removed	421
ning trees pulled back	135
ning trees felled	5,073
ecks removed	2
amboats assisted	2
ges established	3
les run	8,469

Operations of snag boat J. G. Parke.—From July 1 to close of season of 1893 the *rke* was employed on construction work between mouth of Illinois River and uth of Missouri River. She lay during the winter of 1893–'94 and up to June 30, 4, in the canal at Keokuk. In the spring of 1894 she received some repairs, and ll return to service on construction work in the vicinity of Alton. The repairs to e *Parke* were paid for by the general appropriation for improving the Mississippi tween Minneapolis and mouth of Missouri River.

ailable channel depths in feet at the worst bars at lowest stage in 1893, as found by the snag boat General Barnard.

Between St. Paul and Prescott.—Merrimac, 2½; above Robinsons, 2½; head of Island 4; below Grey Cloud, 4 (rock); Point Douglass, 4.
Between Prescott and Lake Pepin.—Foot of Prescott Island, 3½.
Between Wabasha and Winona.—Above Teepeeota Point, 4; below Minneiska, 4; unt Vernon, 4; Van Gorders, 3½.
Between Winona and La Crosse.—Above Lamoille, 3; Hammond Chute, 3½.
Between La Crosse and Paririe du Chien.—Grand Crossing, 3½; above Root River, 4; ove Sand Slough, 4; above Brownsville, 3½; above bridge at Prairie du Chien, 4.
Between Prairie du Chien and Le Claire.—Four Mile Island, 4; Sand Prairie, 4; ve Savanna, 3½; above Lyons, 4.
Between Rock Island and Keokuk.—Above Buffalo, 4; Buffalo, 3½; Fairport, 3½; foot Illinois Chute, 3½; head of Benton Island, 3½; Saurweins, 3½.
Between Keokuk and Quincy.—Upper Bludsoes, 3½; Lower Bludsoes, 3½; Curtis ding, 4; Smoots, 3½; Wyaconda, 3½; above Quincy, 4.
Between Quincy and Clarksville.—Foot Fabius Island, 3½; Upper Whitneys, 4; Armngs, 4; below Saverton, 4; foot Hickory Chute, 4.
Between Clarksville and Missouri River.—Foot Clarksville Island, 3½; Eagle Island, Amaranth Island, 3½; head Westport Island, 4; above Reds, 4; foot of Sterling nd, 3½; Martins Landing, 4; below McCanns, 3½; Dardenne Island, 3½; Bolters nd, 3½; Point Landing, 3½; Enterprise Island, 3½; head Masons Chute, 3½; at fton, 3½; Piasa, 4.

of wrecks between St. Louis and St. Paul which are or may become obstructions to navigation, with approximate dates of sinking, localities, etc.

ten ak.	Names.	Localities.	Remarks.
....	A. J. Baker	Abreast of Gabaree Island; 1 mile above foot and 1,200 feet out from island.	May become an obstruction.
....	Altona	In bar at Montgomerys Tow-head..	Lies on rock bottom, and if tow-head washes away will be in the way of navigation.
....	Baltimore	In bar at Montgomerys Tow-head..	Same as for Altona.
....	Badger State	Lying under wreck of Baltimore ...	Do.
....	Unknown	About halfway between Wilsons Island and Rhodes Point.	May be in the way in the future.
....	Barge	In crossing below Madison	An obstruction at present.
...	Barge	At mouth of Wood River	Sunk close to bank.
...	Unknown	Foot of Maple Island	Now in sand bar.
...	Unknown	Foot of Alton Island	In deep water; makes a strong "break."
....	Chapman	In chute between islands 521 and 522.	May become an obstruction.
...	Iowa	Near head of Iowa Island	
...	Golden Eagle	In chute opposite Martins Landing.	May become an obstruction.
...	Mollie McPike	Carrolls Field, opposite Turners Landing.	Partly removed by U. S. dredge *Phœnix*.
...	Amaranth	Head of Amaranth Island	May become an obstruction.
..	Two barges	Head of Amaranth Island	
..	Mohawk	Head of Clarksville Island	May be in the way.

List of wrecks between St. Louis and St. Paul, etc.—Continued.

When sunk.	Name.	Localities.	Remarks.
1855....	Dubuque	Above Mundys Landing.....	Liable to become a dangerous obstruction.
1854....	Glancus	Opposite head of Glancus Island....	May be in the way soon.
1856....	Wm. H. Denny...	Opposite head of Fabius Island, Illinois side.	Now in dry bar near shore, but may soon be in the way.
1860....	Lucy May.....	About 5 miles below Lagrange.....	In the way.
1893....	Barge	Shore below Lagrange.....	
1893....	Barge.....	At Canton Landing	Much in the way.
1850....	Ferryboat	Bludsoes Crossing.....	In bar.
1880....	Barge	Opposite lower sawmill at Keokuk.	Can be hit at very low water.
1881....	Barge	At Saurweins Point	May be in the way soon.
1853....	Unknown	Below Benton Island	
1880....	Unknown	Near shore 1 mile below Edwards River.	In the way.
1852....	Flatboat.....	Near landing at Port Louisa.....	Near shore. but in the way.
1852....	Flatboat.....	Above foot of island below Buffalo .	In bar; somewhat in the way.
1854....	Dr. Franklin	Foot of Maquoketa Chute	Will soon be in the way.
1871....	Hudson	One mile below Guttenberg	In the way at low water.
1859....	Barge	Below head of Coon Slough	Do.
1891....	Barge	Near U. S. Light at Richtmans.....	In the way.

Locations of rocks between St. Louis and St. Paul which are or may become obstructions to navigation.

In Sawyer Bend.
At and below the chain above St. Louis.
Below Salt River.
In channel opposite foot of Island 420.
Below Lagrange.
Near shore above Lagrange.
Below Des Moines Rapids Canal, near sheer boom.
In draw of Keokuk bridge, near west abutment.
At Des Moines Rapids.
Above Nauvoo, in the crossing at Devils Island.
Rock bottom above Nauvoo Landing.
At Pontoosuc and foot of Dallas Chute.
Above Burlington, at Drews Prairie.
On head of Otter Island and above.
At mouth of Edwards River, near shore.
At and below Oquawka.
Below New Boston, extending from Illinois shore.
Below Keithsburg, in main river and at foot of chute.
Above Muscatine.
At Fairport.
At Montpelier.
First island below Buffalo.
Near shore at Buffalo.
Near shore above Spinneyville.
At and near the head of Smiths Island.
At Horse Island, above and opposite.
At Rock Island Rapids.
In crossing below Cordova.
Above Reeds, at foot of Lake Pepin.
Bowlder reef below Diamond Bluff.
Below Grey Cloud Landing.
In draw of Omaha bridge.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1893 to about 100 towboats, valued at $750,000. Along the river from Minneapolis to St. Louis 75 sawmills were operated by 55 wholesale lumber firms, having an invested capital of about $40,000,000. Their manufactures in 1893 were, lumber, 1,220,576,743 feet, B. M.; shingles, 423,805,250; lath, 290,584,500. This shows a decrease in manufacture, as compared with 1892, of, lumber, 199,954,186 feet, B. M.; shingles, 139,592,025; lath, 59,350,040. This decrease was due to the prevalent business stagnation. In addition to the manufacturers, there are a large number of retail or distributing firms.

Lumber manufacture, Upper Mississippi River Valley, 1893.

Locality.	Lumber.	Shingles.
	Feet, B. M.	*Number.*
Minneapolis	409,000,155	137,908,250
St. Paul to St. Louis	811,576,588	285,897,000
St. Croix River	164,622,159	59,254,750
Black River	174,922,042	91,511,000
Chippewa River	291,766,997	153,066,750
Total	1,851,887,941	727,637,750

The larger part of the above was floated for greater or less distance on the Mississippi River, either as logs or lumber. The total product, if shipped by rail, would

have loaded 168,900 cars of 12,000 feet each (about 20 tons), the quantity generally accepted by lumbermen as a carload. Supposing an average length of car of 35 feet, it would have loaded a train 1,120 miles in length, or 8,445 trains of 20 cars each.

Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1893.

Localtiy.	Lumber.	Shingles.	Lath.
	Feet, B. M.	*Number.*	*Number.*
Minneapolis	409,000,155	137,908,250	100,189,700
St. Paul	1,000,000	.....	.....
Hastings	5,000,000	2,000,000	1,000,000
Redwing	8,500,000	3,500,000	1,000,000
Alma	700,000	1,125,000	154,000
Winona	125,500,000	74,886,000	42,538,000
Lansing	13,500,000	5,300,000	3,018,500
Prairie du Chien	16,500,000	10,500,000	3,500,000
Guttenberg	12,000,000	4,000,000	1,736,200
Dubuque	58,100,000	18,250,000	10,000,000
Bellevue	4,000,000	.....	2,152,000
Lyons	41,850,000	12,600,000	9,015,000
Clinton	175,918,588	43,612,250	23,778,400
Fulton	15,500,000	6,400,000	3,200,000
Moline	32,000,000	4,000,000	3,400,000
Davenport	56,678,000	9,950,000	11,750,000
Rock Island	94,380,000	24,846,000	22,705,000
Muscatine	44,100,000	9,500,000	12,500,000
Burlington	23,700,000	4,700,000	15,100,000
Fort Madison	19,800,000	10,950,000	6,270,000
Keokuk	12,000,000	7,000,000	3,000,000
Canton	5,850,000	5,277,750	2,777,700
Quincy	23,000,000	16,500,000	5,800,000
Hannibal	22,000,000	11,000,000	6,000,000
Total	1,220,576,743	423,805,250	290,584,500

Lumber manufacture on the Mississippi River from St. Paul to St. Louis for eight years.

Year.	Lumber.	Shingles.	Lath.
	Feet B. M.	*Number.*	*Number.*
1893	811,576,588	285,897,000	190,394,800
1892	931,806,305	357,014,775	228,042,910
1891	814,228,707	332,666,750	207,722,350
1890	1,231,678,960	506,986,705	.....
1889	1,044,555,298	463,132,700	.....
1888	1,048,951,386	423,655,050	.....
1887	988,361,094	363,239,750	.....
1886	934,735,854	274,581,750	267,888,340
Total	7,805,894,192	3,009,174,480	.....

Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the Diamond Jo Line, the Eagle Packet Company, and the Joy Lumber Line. There are also many independent boats carrying freight and passengers. During the season of 1893 the amount of freight and number of passengers carried on boats and barges could not be accurately ascertained, but partial reports give 109,884 tons of freight and 142,602 passengers, not including those of ferry and excursion boats.

Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1893 was approximately 3,200,000 tons.

Statement of approximate tonnage of the Upper Mississippi River for eight years.

Year.	Tons.	Year.	Tons.
1886	3,200,000	1890	4,200,000
1887	3,500,000	1891*	3,300,000
1888	3,750,000	1892	3,750,000
1889	3,500,000	1893†	3,200,000

* Very low water. † Great business depression.

NOTE.—The tonnage as now given differs somewhat from the statements in previous reports, but the present estimates are believed to be more nearly correct.

Statement of amount of freight received at and shipped from St. Louis by the Upper Mississippi, including logs and lumber, for four years.

St. Louis.	1893.	1892.	1891.	1890.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Received	111,710	265,655	232,955	261,900
Shipped	54,230	51,595	18,630	22,547
Total	165,940	317,250	251,585	284,447

Arrivals at and departures from St. Louis during 1893.

Steamboats and barges from Upper Mississippi River arrived at St. Louis 947
Steamboats and barges departed from St. Louis for Upper Mississippi River.... 945

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

List of steamers, barges, and rafts passing through various bridges.

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1893.	1892.	1891.	1893.	1892.	1891.	1893.	1892.	1891.
Hastings	487	601	503	327	579	510	90	88	43
Winona	4,428	5,268	3,687	1,324	957	1,108	1,655	1,759	1,495
La Crosse	3,956	4,984	3,547	2,091	1,047	568	1,407	1,901	1,265
Dubuque	2,744	3,385	2,649	1,253	1,458	1,190	627	736	*585
Sabula	2,784	3,247	2,844	1,233	1,240	613	1,097	*20	*20
Clinton	2,491	3,253	2,821	659	719	622	411	*423	*602
Rock Island	2,183	1,847	2,694	485	1,805	571	576	756	634
Keithsburg	1,108	(†)	(†)	(†)	(†)	(†)	(†)	(†)	(†)
Burlington	1,377	1,750	1,620	426	533	751	380	494	411
Fort Madison	1,252	(†)	(†)	(†)	(†)	(†)	(†)	(†)	(†)
Keokuk	1,678	2,687	1,209	1,586	2,040	420	153	201	165
Quincy	1,478	2,050	1,604	624	784	615	178	291	189
Hannibal	1,798	1,775	1,637	1,117	650	590	309	396	319
Louisiana	1,313	968	944	797	530	590	53	103	66

* Partial record. † No record.

The following table shows the navigation during a period of sixteen years through Winona bridge, at which point the traffic is the largest:

Statement of steamers, barges, and rafts passing Winona bridge during sixteen years.

Year.	Steamboats.	Barges.	Rafts.	Year.	Steamboats.	Barges.	Rafts.
1878	2,948	1,115	863	1886	4,570	974	1,868
1879	3,760	1,362	1,889	1887	4,300	1,600	1,100
1880	4,593	883	1,392	1888	4,740	684	1,894
1881	4,739	575	1,717	1889	4,419	1,140	1,387
1882	5,627	942	1,939	1890	5,417	1,945	2,123
1883	4,893	828	1,352	1891	3,687	1,108	1,495
1884	4,992	905	2,007	1892	5,268	957	1,759
1885	5,126	848	1,973	1893	4,428	1,324	1,655

Internal revenue for the year ending December 31, 1893, collected in districts bordering on the Upper Mississippi River.

Locality.	Office.	Amount.
Minnesota	St. Paul	$12,236,279.56
Second Wisconsin	Madison	262,510.10
Third Iowa	Dubuque	175,776.12
Fourth Iowa	Burlington	342,868.32
Fifth Illinois	Peoria	13,389,761.96
Eighth Illinois	Springfield	6,522,058.41
Thirteenth Illinois	Cairo	533,929.87
First Missouri	St. Louis	7,306,799.51
Aggregate		20,769,084.05

Customs revenue and tonnage for the year ending December 31, 1894.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Paul	$400,501.88	2,460.01	30
La Crosse, Wis	5.50	4,823.87	60
Dubuque, Iowa	18,357.72	512,964.00	21
Rock Island, Ill		6,159.76	59
Burlington, Iowa	2,365.40	365.71	5
St. Louis, Mo.*	1,091,947.79	7,838.10	28
Total	1,513,178.29	534,611.45	203

* Only a part of the St. Louis statement applicable to the Upper Mississippi.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

Under this head of appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in constructions of rock, brush, piles, and gravel, which close side chutes and properly contract the low-water channel, and in the protection of caving banks by use of the same materials. Between Minneapolis and St. Paul, in addition to works of construction, bowlders are removed and channels dredged through gravel bars; at Rock Island Rapids, guide piers, to aid in the navigation of the rapids at night, are built, and rock ledges above grade within the proposed channel limits are removed by drilling, blasting, and dredging. The appropriation also provides for a certain amount of dredging and other temporary work for the more rapid and immediate removal of obstructions to navigation.

At the commencement of the fiscal year there was available the sum of $937,287.45. Work was carried on vigorously in 1893, subsequent to June 30, but in 1894 little besides contract work has been accomplished, funds available being insufficient to warrant placing our plants in the field. Under approved projects work of dam construction, shore protection, and removal of rocks and bowlders has been carried on during the past year by days' labor and Government plant between St. Paul and Lake Pepin, between Minneiska and Genoa; at Rock Island Rapids, between Keithsburg and Montrose; at head of Des Moines Rapids; at vicinity of Canton, between Quincy and Clarksville; at Westport Chute, and between the Illinois and Missouri rivers. Under formal contract, dam and shore protections were constructed between Smiths Bar and Lake Pepin, between Genoa and Prairie du Chien, between Glenhaven and Dubuque, between Dubuque and Clinton, between Keokuk and Quincy, between Quincy and Hannibal, between Clarksville and Hamburg, between Hamburg and Cap au Gris, and between Cap au Gris and the mouth of the Illinois River.

At Burlington Harbor no work was found necessary during the year, and the balance ($3,094.38) remaining from the allotment in act of September 19, 1890, is still available.

Surveys and examinations were made between St. Paul and Lak Pepin, at Moline Pool, vicinity of Keithsburg, above Burlington, an at Twin Islands; also continuous surveys of the river from Minneisk to Crooked Slough, 100 miles, and from Clayton to Le Claire, 138 miles

Extensive repairs were made to the plant belonging to this appro priation, and many pieces were added during the year.

The details of all the above-mentioned work are fully given in th appended reports of assistants in local charge.

Minneapolis to St. Paul.—The act of Congress of August 11, 188 provided in a general way for work of improvement between Minn apolis and St. Paul, and the act of September 19, 1890, allotted a specifi amount ($50,000) for carrying on specified work on this section of th river. Details of work performed are given in former reports.

There is available for this work from the appropriation of 1890 th sum of $49,892.17.

Under date of February 15, 1893, I was directed by the Chief Engineers to prepare new and exact estimates for locks and dams f this portion of the river, and to submit to him the results when reache Surveys were made during the low-water season of 1893. My repo was rendered March 1, 1894, and is included in Senate Ex. Doc. N 109, Fifty-third Congress, second session.

Improving Quincy Bay, Illinois.—The river and harbor act of Ju 13, 1892, contains the following clause:

> Improving Quincy Bay, Illinois: The balance on hand to credit of this impro ment from the appropriation made in the river and harbor act of September ni teenth, eighteen hundred and ninety, is hereby authorized to be expended, or much thereof as may be necessary, in constructing a retaining levee on Whip Creek Bar to hold the material dredged from the bay, as recommended by the en neer in charge in the report for eighteen hundred and ninety-one, page twenty- hundred and twenty-one.

A project for a retaining levee or bulkhead on Whipple Creek B was submitted February 25, 1893, and approved March 3, 1893. C tract for the work was let to Mr. H. S. Brown, the lowest bidder. T construction of the bulkhead was commenced in June, 1893, and co pleted in June, 1894.

Commercial statistics relating to the Upper Mississippi River a given in connection with the report on "operating snag boats and dred boats on Upper Mississippi River." These statistics do not fully in cate the relations of this work to the interests of commerce and t general public. The influence which the Upper Mississippi River in i improved condition has upon freight rates must be taken as a measu of its importance. Of the amount of freight carried by railroads at riv rates, as a result of the river competition, no figures can be given; b such amount is known to be very large during the season when navig tion of the river is practicable.

During the past year the works heretofore constructed by the Gov ernment have continued to straighten and deepen the low-water chan nel of the river, and to materially benefit the interests of commerc and navigation. That such benefit should continue and increase, it i necessary that the work of improvement be continued until the whol river is put under such control that the possibility of new obstruction appearing is done away with.

If the radical improvement of the Upper Mississippi River is to l continued and carried to the full limits which the immense interes involved justify, it is desirable that it should be carried on under l eral appropriations, so that the full benefit of the improvement may

secured at as early a day as is practicable. As an amount that can be profitably expended during the fiscal year ending June 30, 1896, I present an estimate of $866,666.67.

The improvement of the Upper Mississippi River is a work which can be best carried on so gradually as to give the river itself full opportunity to assist in the formation of proper channels, and if carried to its fullest limits the work must extend over many years. It does not now appear desirable, or even practicable, to prepare detailed plans for the whole river so long in advance of the time when it may be possible or necessary to carry out some of the work. The existing project for this work may therefore be said to be one of general methods and the execution of detailed plans for special localities. Under the conditions named no detailed estimates of cost of completing the entire work can well be now made. Projects for the expenditure of each appropriation, in accordance with approved plans and methods, are presented in lieu of a general project for the completion of work. It has been the custom in carrying out work on the Upper Misssissippi to select, when funds are available, such localities for improvement as may be at the time most detrimental to navigation. Each and every locality thus improved has a beneficial result on the navigation of the whole river, and as the shoalest bars have been improved from year to year the ruling navigable depth has been considerably increased. By this method the good effects of work are spread over the entire stretch of river, and the improvement of the river, considered as a whole, is made progressive, the expenditure of each successive appropriation resulting in further and immediate benefit to the interests of continuous navigation.

Summary of expenditures for calendar year ending December 31, 1893, under appropriations for improving Mississippi River, "Ohio River to Minneapolis," applied to that portion of the river between the mouth of the Missouri River and Minneapolis; "Minneapolis to Des Moines Rapids," and "Des Moines Rapids to Illinois River."

Minneapolis to Saint Paul (survey)	$4,994.41
Saint Paul to Lake Pepin	70,434.15
Smiths Bar to Lake Pepin	29,770.38
Reeds Landing to Minneiska	34,008.64
Dredging at Chimney Rock	8,006.35
Minneiska to Genoa	122,372.67
Genoa to Prairie du Chien	83,729.57
Glenhaven to Dubuque	49,439.79
Dubuque to Clinton	45,154.90
Rock Island Rapids	56,377.54
Buoys on Rock Island Rapids	545.98
Dredging below Keithsburg	938.94
Keithsburg to Montrose	38,878.47
Keokuk to Quincy	70,730.76
Quincy Bay	8,283.17
Quincy to Hannibal	8,048.94
Quincy to Clarksville	66,807.63
Clarksville to Hamburg	20,052.96
Hamburg to Cap au Gris	39,386.85
Illinois River to Missouri River	65,722.25
Purchase, construction, care, and repair of plant	85,402.28
Surveys and gauges	14,017.81
Total	923,108.44

NOTE.—In above statement retained percentages on contracts and other liabilities outstanding December 31, 1893, are included.

Abstract of appropriations.

St. Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000.00
March 3, 1879	100,000.00
June 14, 1880	150,000.00
March 3, 1881	200,000.00
By act passed August 2, 1882	250,000.00
By act approved—	
July 5, 1884 (general improvement)	250,000.00
July 5, 1884 (applied to harbor Lake City)	15,000.00
August 5, 1886	382,500.00
Minneapolis to Des Moines Rapids:	
By act of—	
August 11, 1888	600,000.00
September 19, 1890	500,000.00
Des Moines Rapids to Illinois River:	
By act approved—	
June 18, 1878	100,000.00
March 3, 1879	40,000.00
June 14, 1880	100,000.00
March 3, 1881	175,000.00
By act passed August 2, 1882	200,000.00
By act approved—	
July 5, 1884	200,000.00
August 5, 1886	150,000.00
By act of—	
August 11, 1888	200,000.00
September 19, 1890	165,000.00
Ohio River to Minneapolis, applied to Missouri River to Minneapolis:	
By act approved—	
July 13, 1892	600,000.00
March 3, 1893 (sundry civil)	866,666.67
Total	5,494,166.67

General statement showing net expenditures from the commencement of improvement to July 1, 1894, under various appropriations.

St. Paul to Des Moines Rapids		$1,560,323.17
Practical test of Adams Flume (St. Paul to Des Moines Rapids)		*22,176.83
Harbor at Lake City (St. Paul to Des Moines Rapids)		15,000.00
Minneapolis to Des Moines Rapids		1,096,905.62
Des Moines Rapids to Illinois River		1,330,000.00
Ohio River to Minneapolis (applied to "between mouth of Missouri River and Minneapolis")		1,176,301.63
Total net expenditures		5,200,707.25
Balances July 1, 1894—		
Minneapolis to Des Moines Rapids	†$3,094.38	
Ohio River to Minneapolis	‡290,365.04	
		293,459.42
Total appropriated		5,494,166.67

*In addition to this amount Mr. Adams expended $13,000 appropriated by acts of August 2, 1882, and July 13, 1892.

†Belongs to harbor at Burlington, Iowa.

‡Of this balance, $49,892.17 pertains to Minneapolis to St. Paul.

tures on the various sections of the river between Minneapolis and the Missouri River from commencement of improvement to July, 1894.

Locality.	Distance.	Amount.
	Miles.	
to St. Paul (Omaha bridge)	11	$59,098.70
aha bridge) to Prescott	32	638,498.56
ake Pepin	29	111,409.17
ke City		16,091.62
Pepin to Alma	12	341,439.26
ona bridge	29	365,394.25
ge to La Crosse bridge	31	236,139.39
idge to McGregor bridge	72	308,311.07
idge to Dubuque bridge	59	137,236.65
dge to Clinton bridge	67	131,905.29
ge to Rock Island bridge	40	228,298.99
bridge to Keithsburg bridge	58	70,071.85
ridge to Des Moines Rapids	60	515,971.20
uincy bridge	40	355,263.71
e to Clarksville	60	552,051.47
o Cap au Gris	43	389,959.31
to Illinois River	27	137,116.97
r to Missouri River	25	70,688.77
		44,481.36
y		10,000.00
		56,728.99
ges, and meter work		162,619.17
dge boats and wrecking		59,661.11
navigation through bridges		1,412.18
t of Adams Flume		27,176.83
mated value		173,681.38
		5,200,707.25

* $25,000 additional expended at Quincy Bay under special appropriation.

Money statements.

MINNEAPOLIS TO DES MOINES RAPIDS.

3, balance unexpended:		
en Chicago, St. Paul, Minneapolis, and Omaha Railroad bridge		
Washington avenue bridge		$4,585.83
r at Burlington		3,094.38
		7,680.21
94, amount expended during fiscal year between Chicago, St. Minneapolis, and Omaha Railroad bridge and Washington avenidge		4,585.83
4, balance unexpended		3,094.38

DES MOINES RAPIDS TO ILLINOIS RIVER.

3, balance unexpended	$11,987.55
94, amount expended during fiscal year	11,987.55

R TO MINNEAPOLIS, APPLIED TO THAT PORTION OF THE RIVER BETWEEN THE MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

3, balance unexpended		$1,198,178.44
94, amount expended during fiscal year		907,813.40
4, balance unexpended		290,365.04
4, outstanding liabilities	*$10,623.16	
4, amount covered by uncompleted contracts	†141,902.05	
		152,525.21
4, balance available		137,839.83

*Of this amount $468.73 are nonpayments.
†Includes retained percentage.

Amount (estimated) required for completion of existing project	Unknown.
Amount that can be profitably expended in fiscal year ending June 30, 1896	$866,666.67
Submitted in compliance with requirments of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., July 6, 1893, at 2 p. m.

[Available for this work from appropriation of $1,500,000 made by the sundry civil act approved March 3, 1893, for "improving Mississippi River from mouth of Ohio River to Minneapolis," under an allotment of $866,666.67, made by said act for "improving Mississippi River between mouth of Missouri and Minneapolis."]

FURNISHING ROCK ON UNITED STATES BARGES BETWEEN ST. PAUL AND LAKE PEPIN, MINNESOTA.

[Allotment of $65,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	10,000 cubic yards rock.	
		Price per cubic yard.	Total.
		Cents.	
1	Mathew Ahern, Charle Sjogren, and John Sjogren, Hastings, Minn	56	$5,600
2	Peter J. Peterson, Red Wing, Minn	55	5,500
3	Andrew Danielson and John Seastrand, Red Wing, Minn	70	7,000
4	John Killeen, Davenport, Iowa	83	8,300
5	John Benson, Hastings, Minn.[1]	54½	5,450
6	Thomas W. Hope, Diamond Bluff, Wis.[2]	85	.....

[1]Recommended for acceptance; accepted, and written contract made. [2]5,000 cubic yards.

FURNISHING BRUSH ON UNITED STATES BARGES BETWEEN ST. PAUL AND LAKE PEPIN, MINNESOTA.

[Allotment of $65,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	30,000 cubic yards brush.	
		Price per cubic yard.	Total.
		Cents.	
1	Alfred Anderson and August Peterson, Red Wing, Minn	36	$10,800
2	Mathew Ahern, Charle Sjogren and John Sjogren, Hastings, Minn	30	9,000
3	Owen P. Sherry, Hastings, Minn.[1]	34	.....
4	Christian Massueger, Fountain City, Wis.[2]	29½	8,850
5	Frank N. Truax, St. Paul Park, Minn.[3]	29½	.....
6	Herbert Ames, St. Paul Park, Minn.[4]	36 33 36	10,500
7	Edward Du Shane and George W. Speaks, Hastings, Minn.[5]	35	.....

[1]5,000 cubic yards.
[2]Recommended for acceptance; accepted, and written contract made.
[3]7,500 cubic yards.
[4]10,000 cubic yards between Red Wing and Hastings, Minn., 36 cents; 10,000 cubic yards between Hastings and Grey Cloud Island, Minnesota, 33 cents; 10,000 cubic yards between Grey Cloud Island and St. Paul, Minn., 36 cents.
[5]3,000 cubic yards

Abstract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

CONSTRUCTION OF SHORE PROTECTIONS BETWEEN SMITHS BAR AND LAKE PEPIN.

[Allotment of $50,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	30,000 cubic yards rock in place.		20,000 cubic yards brush in place.		Grand Total.
		Price per cubic yard.	Total.	Price per cubic yard.	Total.	
				Cents.		
1	Jacob Richtman, Fountain City, Wis.[1]	$1.20	$36,000	40	$8,000	$44,000
2	Albert Kirchner, Fountain City, Wis	1.40	42,000	75	15,000	57,000
3	Sid J. Truax, Hastings, Minn	1.10	33,000	67	13,400	46,000
4	Christian Massueger, Fountain City, Wis	1.57	47,100	53	10,600	57,700

[1] Recommended for acceptance; accepted, and written contract made.

FURNISHING RIPRAP ROCK ON UNITED STATES BARGES BETWEEN FOUNTAIN CITY, WIS., AND BROWNSVILLE, MINN.

[Allotment of $60,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	10,000 cubic yards rock.	
		Price per cubic yard.	Total.
		Cents.	
1	Nelson Breed, Homer, Minn., and Thomas H. Botham, Winona, Minn	67	$6,700
2	John Killeen, Davenport, Iowa	83	8,300
3	Edgar R. Leach, Richmond, Minn	54	5,400
4	George Palmer, Brownsville, Minn.[1]	70	.....
5	Albert Kirchner, Fountain City, Wis	[2]53	5,300
		[3]70	7,000
6	R. E. Hazen, Lynxville, Wis	75	7,500

[1] 2,500 cubic yards.
[2] Sand rock, 53 cents. Recommended for acceptance; accepted, and written contract made.
[3] Lime rock.

FURNISHING BRUSH ON UNITED STATES BARGES BETWEEN FOUNTAIN CITY AND GENOA, WIS.

[Allotment of $60,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	25,000 cubic yards brush.	
		Price per cubic yard.	Total.
		Cents.	
1	Jacob Schmoker, Fountain City Wis	26	$6,500
2	Anton Zehren, Buffalo City, Wis	27	6,750
3	Henry F. Murr, Fountain City, Wis	28	7,000
4	Christian Massueger, Fountain City, Wis.[1]	24½	6,125

[1] Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN GENOA AND PRAIRIE DU CHIEN, WIS.

[Allotment of $50,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Price per cubic yard.	Total.	Price per cubic yard.	Total.	
				Cents.		
1	Jacob Richtman, Fountain City, Wis	$1.40	$35,000	60	$15,000	$50,000
2	Christian Massueger, Fountain City, Wis	1.39	34,750	65	16,250	51,000
3	Sid. J. Truax, Hastings, Minn	1.10	27,500	67	16,750	44,250
4	Albert Kirchner, Fountain City, Wis	1.30	32,500	55	13 750	46,250
5	V. A. Bigelow, Lacrosse, Wis., and A. B. Teasdale, Cassville, Wis.[1]	1.14	28,500	40	10,000	38,500

[1] Recommended for acceptance; accepted and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN DUBUQUE AND CLINTON, IOWA.

[Allotment of $50,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Price per cubic yard.	Total.	Price per cubic yard.	Total.	
1	Sid. J. Truax, Hastings, Minn	$1.28	$32,000	$0.67	$16,750	$48,750
2	Jacob Richtman, Fountain City, Wis	1.40	35,000	.60	15,000	50,000
3	Albert Kirchner, Fountain City, Wis	1.45	36,250	.65	16,250	52,250
4	Patterson Bros., Keokuk, Iowa	1.24	31,000	.50	12,500	43,500
5	A. J. Whitney, Rock Island, Ill	1.37	34,250	.57	14,250	48,500
6	V. A. Bigelow, Lacrosse, Wis., and A. B. Teasdale, Cassville, Wis.[1]	1.24	31,000	.47	11,750	42,750
7	John Adams, Madison, Ind	1.80	45,000	1.20	30,000	75,000

[1] Recommended for acceptance; accepted and written contract made.

FURNISHING RIPRAP ROCK ON UNITED STATES BARGES BETWEEN KEITHSBURG, ILL., AND MONTROSE, IOWA.

[Allotment of $50,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	30,000 cubic yards brush.	
		Per cubic yard.	Total.
1	John Killeen, Davenport, Iowa	$0.83	$20,750
2	Feasley Bros., Dallas City, Ill.[1]	90	.....
3	Christian Mathes, Burlington, Iowa[2]	74	.....
4	Becker & Moyes, Pontoosuc, Ill.[3]	78	.....
5	Siens & Bro., Pontoosuc, Ill.[4]	78	.....
6	Henry C. Berger, Nauvoo, Ill.[5]	1.05	.....
7	Geo. H. Schafer, Fort Madison, Iowa[6]	78	.....
8	William Engelhard, Pontoosuc, Ill.[7]	78	.....
9	Ernest G. Kemper, Burlington, Iowa[8]	79½	.....
10	Amos K. Roberts, Nauvoo, Ill.[9]	63½	16,325
11	Chas. H. Kemper, Burlington, Iowa[10]	68	
12	Samuel Monroe, Portsmouth, Ohio	87	.....
		79	19,750

[1] 1,000 cubic yards.
[2] 10,000 cubic yards.
[3] 2,000 cubic yards.
[4] 5,000 cubic yards.
[5] 12,000 cubic yards.
[6] 5,000 cubic yards.
[7] 2,000 cubic yards.
[8] 10,000 cubic yards.
[9] 15,000 cubic yards at Nauvoo, Ill., 63½ cents; 10,000 cubic yards at Burlington, Iowa, 68 cents. Recommended for acceptance; accepted and written contract made.
[10] 10,000 cubic yards.

stract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

ISHING BRUSH ON UNITED STATES BARGES BETWEEN KEITHSBURG, ILL., AND MONTROSE, IOWA.

[Allotment of $50,000 made by project approved May 8, 1893.]

Name and address of bidder.	30,000 cubic yards brush.	
	Per cubic yard.	Total.
	Cents.	
asaway Bros., Dallas City, Ill.[1]	30	.....
has. F. Winters, Fort Madison, Iowa.[2]	33	.....
	35	.....
hilip Pence, Lomax, Ill.[3]	40	.....
ilward H. Rogers, New Boston, Ill.[4]	28	.....
m. A. Shain, Dallas City, Ill.[5]	30	.....
hristian Massueger, Fountain City, Wis.	30	$9,000

0 cubic yards. Recommended for acceptance; accepted and written contract made.
0 cubic yards at Port Louisa, Iowa, 33 cents; 12,500 cubic yards at Keithsburg, Ill., 35 cents.
) cubic yards.
0 cubic yards. Recommended for acceptance; accepted and written contract made.
cubic yards. Recommended for acceptance; accepted and written contract made.

ISHING RIPRAP ROCK ON UNITED STATES BARGES BETWEEN HANNIBAL AND CLARKSVILLE, MO.

[Allotment of $35,000 made by project approved May 8, 1893.]

Name and address of bidder.	15,000 cubic yards rock.	
	Price per cubic yard.	Total.
	Cents.	
hn Killeen, Davenport, Iowa	85	$12,750
enry L. Hart, Louisiana, Mo.	72	10,800
muel Monroe, Portsmouth, Ohio	74	11,100
ystal Carbonate Lime Co., Louisiana, Mo.[1]	58	8,700

[1] Informal. Recommendation that all bids be rejected.

ISHING BRUSH ON UNITED STATES BARGES BETWEEN QUINCY BRIDGE AND CLARKSVILLE, MO.

[Allotment of $35,000 made by project approved May 8, 1893.]

Name and address of bidder.	20,000 cubic yards brush.	
	Price per cubic yard.	Total.
	Cents.	
enry L. Hart, Louisiana, Mo	32	$6,400
hn Alcorn, Hannibal, Mo.[1]	25	.....
hraim Kimmel and Aariah Brown, Quincy, Ill.	38	7,600
muel Monroe, Portsmouth, Ohio[2]	30	6,000
L. Nichols, Fort Madison, Iowa[3]	26	.....

[1] 2,000 cubic yards. Informal bid.
[2] Recommended for acceptance; accepted and written contract made.
[3] 10,000 cubic yards. Informal bid.

Abstract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN CLARKSVILLE, MO., AND HAMBURG, ILL.

[Allotment of $50,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Price per cubic yard.	Total.	Price per cubic yard.	Total.	
1	James Short, St. Charles, Mo.[1]	$1.35	$33,750	$0.49	$12,250	$46,000
2	Jacob Richtman, Fountain City, Wis	1.30	32,500	.60	15,000	47,500
3	Patterson Bros., Keokuk, Iowa	1.60	40,000	.80	20,000	60,000
4	Albert Kirchner, Fountain City, Wis	1.40	35,000	.60	15,000	50,000
5	Sid. J. Truax, Hastings, Minn	1.48	37,000	.75	18,750	55,750
6	John Adams, Madison, Ind	1.70	42,500	1.10	27,500	70,000

[1] Recommended for acceptance; accepted and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN HAMBURG, ILL., AND CAP AU GRIS., MO.

[Allotment of $75,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	37,000 cubic yards rock in place.		37,000 cubic yards brush in place.		Grand total.
		Price per cubic yard.	Total.	Price. per cubic yard.	Total.	
1	H. S. Brown, Quincy, Ill	$1.40	$51,800	$0.80	$29,600	$81,400
2	Thompson & Gray, St. Charles, Mo	1.34	49,580	.49	18,130	67,710
3	Jacob Richtman, Fountain City, Wis.[1]	1.25	46,250	.50	18,500	64,750
4	Albert Kirchner, Fountain City, Wis	1.35	49,950	.60	22,200	72,150
5	Hunter & Frey, Memphis, Tenn	1.45	53,650	.55	20,350	74,000
6	Patterson Bros., Keokuk, Iowa	1.75	64,750	.75	27,750	92,500
7	John Adams, Madison, Ind	1.65	61,050	1.05	38,850	99,900

[1] Recommended for acceptance; accepted, and written contract made.

CONSTRUCTION OF DAMS AND SHORE PROTECTIONS BETWEEN CAP AU GRIS, MO., AND MOUTH OF ILLINOIS RIVER.

[Allotment of $60,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	30,000 cubic yards rock in place.		30,000 cubic yards brush in place.		Grand Total.
		Price per cubic yard.	Total.	Price per cubic yard.	Total.	
1	James Short, St. Charles, Mo.[1]	$1.24	$37,200	$0.44	$13,200	$50,400
2	H. S. Brown, Quincy, Ill	1.20	36,000	.75	22,500	58,400
3	Jacob Richtman, Fountain City, Wis	1.30	39,000	.60	18,000	57,000
4	Albert Kirchner, Fountain City, Wis	1.40	42,000	.60	18,000	60,000
5	Hunter & Frey, Memphis, Tenn	1.45	43,500	.55	16,500	60,000
6	Patterson Bros., Keokuk, Iowa	1.50	45,000	.60	18,000	63,000
7	A. J. Whitney, Rock Island, Ill	1.49	44,700	.65	19,500	64,200
8	John Adams, Madison, Ind	1.60	48,000	1.00	30,000	78,000

[1] Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, etc.—Continued.

FURNISHING BRUSH ON UNITED STATES BARGES WITHIN 25 MILES OF PIASA ISLAND, ILLINOIS, UPON THE MISSISSIPPI OR MISSOURI RIVERS.

[Allotment of $90,000 made by project approved May 8, 1893.]

No.	Name and address of bidder.	50,000 cubic yards brush.	
		Price per cubic yard.	Total.
		Cents.	
1	Henry L. Hart, Louisiana, Mo.[1]	32	.....
2	Christian Massueger, Fountain City, Wis	49½	$24,750
3	Samuel Monroe, Portsmouth, Ohio	44	22,000
4	John Gray, Canton, Mo	27	13,500
5	Hunter & Frey, Memphis, Tenn.[2]	24	12,000

[1] 20,000 cubic yards.
[2] Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., August 24, 1893, at 2 p. m., for construction of dams and shore protections between Quincy bridge and Hannibal, Mo.

[Available for this work from appropriation of $1,500,000 made by the sundry civil act approved March 3, 1893, for "improving Mississippi River from mouth of Ohio River to Minneapolis," under an allotment of $866,666.67 made by said act for "improving Mississippi River between mouth of Missouri and Minneapolis," an allotment of $50,000 made by project approved July 27, 1893.]

No.	Name and address of bidder.	25,000 cubic yards brush in place.		25,000 cubic yards rock in place.		Grand total.
		Price per cubic yard.	Total.	Price per cubic yard.	Total.	
		Cents.				
1	Thompson & Gray, St. Louis, Mo.[1]	53	$13,250	$1.43	$35,750	$49,000
2	Fruin-Bambrick Construction Co., St. Louis, Mo	80	20,000	1.20	30,000	50,000
3	John Killeen, Davenport, Iowa	60	15,000	1.40	35,000	50,000
4	Sid. J. Truax, Hastings, Minn	74	18,500	1.20	30,000	48,500
5	Jacob Richtman, Fountain City, Wis	60	15,000	1.40	35,000	50,000
6	Albert Kirchner, Fountain City, Wis	50	12,500	1.20	30,000	42,500
7	H. S. Brown, Quincy, Ill	54	13,500	1.20	30,000	43,500
8	McGee, Kahmann & Co., Kansas City, Mo.[2]	50	12,500	1.33	33,250	45,750
9	Patterson Bros., Keokuk, Iowa[3]	43	10,750	1.09	27,250	38,000

[1] Informal; proposal not dated.
[2] Informal; guaranty incomplete.
[3] Recommended for acceptance; accepted and written contract made.

Comparative cost of materials, 1892 and 1893.

Locality of delivery.	Rock (per cubic yard).			Brush (per cubic yard).		Poles.
	In place.	On United States barges.	On bank.	In place.	On United States barges.	Each.
1892.						
St. Paul to Merrimac	.....	$0.65	.....	.....	.....	.....
Newport	.....	.....	.....	.....	$0.29	$0.02½
Grey Cloud Island and Nininger	.....	.....	.....	.....	.28	.03
Nininger	.....	.42	.....	.....	.....	.....
Do	.....	.44	$0.31½	.....	.....	.....
Do	.....	.....	.....	.....	.29	.03
Do	.....	.62	.....	.....	.....	.....
Nininger to Hastings	.....	.....	.....	.....	.28½	.....
Hastings to Redwing	.....	.49	.....	.....	.28	.03
Reeds Landing to Minneiska	$1.53	.....	.....	$0.54	.....	.....
Fountain City	.....	.....	.....	.....	.20	.03
Richmond	.....	*.40	.....	.....	.....	.....

* Soft sand rock.

Comparative cost of materials, 1892 and 1893—Continued.

Locality of delivery.	Rock (per cubic yard)			Brush (per yard).	
	In place.	On United States barges.	On bank.	In place.	On S ba
1892.					
Dakota		$0.40*			
Dresbach		.50			
Genoa to Prairie du Chien	$1.40			$0.66	
Dubuque to Clinton	1.40			.59	
Rock Island Rapids		.65			
Do		.67	$0.35		
Keithsburg					
Do					
Keithsburg to Montrose					
Burlington		.78			
Do		.60			
Shokokon to Dallas					
Niota		.55	.40		
Pontoosuc		.78			
Do		.55	.40		
Nauvoo					
Keokuk		.69			
Gregory Landing					
Lagrange		.69½			
Quincy		.62			
Hannibal		.53			
Louisiana		.62			
Hamburg					
1893.					
St. Paul to Lake Pepin		.54½			
Newport					
Grey Cloud Island					
Nininger		.62			
Do		.54½			
Smiths Bar to Lake Pepin	1.20			.40	
Minneiska to Lacrosse		.53			
Do					
Chimney Rock, vicinity of		.60			
Fountain City to Brownsville		*.53			
Fountain City to Genoa					
1893.					
Richmond		*.50			
Genoa to Prairie du Chien	1.14			.40	
De Soto					
Glenhaven to Dubuque	1.40			.59	
Dubuque to Clinton	1.24			.47	
Rock Island Rapids		.55			
Rock Island Rapids		.67			
Keithsburg to Montrose					
Barkis Island to Montrose					
Burlington		.68			
Shokokon to Dallas					
Dallas					
Dallas					
Pontoosuc		.55			
Pontoosuc		.78			
Nauvoo		.63½			
Keokuk to Quincy	1.37			.47	
Gregory Landing					
Canton					
Quincy to Hannibal					
Quincy bridge to Hannibal	1.09			.43	
Quincy bridge to Clarksville					
Hannibal		.53			
Hannibal		.54½			
Hannibal		.58			
Louisiana		.62			
Louisiana					
Louisiana		.58			
Clarksville to Hamburg	1.35			.49	
Hamburg					
Hamburg to Cap au Gris	1.25			.50	
Cap au Gris					
Cap au Gris to mouth of Illinois River	1.24			.44	
Grafton		.43			
Piasa Island, vicinity of					

* Soft sand rock.

REPORT OF MR. J. D. DUSHANE, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., March 9, 1894.

MAJOR: I have the honor to submit the following report of operations under my direction for improving the Mississippi River between Minneapolis and Lake Pepin for the calendar year ending December 31, 1893.

MINNEAPOLIS TO ST. PAUL.

To comply with a letter, dated Office Chief of Engineers, U. S. Army, February 15, 1893, desiring new and exact estimates for locks and dams for improving the Mississippi River between St. Paul and the Falls of St Anthony, surveys on which to base these estimates were made during the low-water season of 1893.

From the falls to the Marshall Avenue bridge a transit line and levels were run on each bank of the river, and detailed surveys were made at Riverside Park, Meekers Island, below the Chicago, Milwaukee and St. Paul Railway bridge, and at Minnehaha Creek. At each locality numerous borings were made, to determine the elevation of the soft sand rock and the character of the river bed. For the borings in the river a well-digger's machine was used, mounted on U. S. drill boat 34 and operated by steam; on shore and in shoal water horse machines and hand drills were used. Permanent monuments were established at each locality. The field work, in the immediate charge of Mr. Rufus Cook, was begun July 27 and completed November 17, 1893.

I would recommend that a line of levels be run with great care between the Marshall avenue bridge and the Chicago, St. Paul, Minneapolis and Omaha Railway bridge during 1894, to connect with the Mississippi River Commission levels at St. Paul.

I am indebted to the Minneapolis Mill Company for access to their office records relating to surveys of the river and stage of water and for other courtesies, and to Mr. J. T. Fanning for a copy of his table of the "flow of the Mississippi River at the Falls of St. Anthony from 1880 to 1889 inclusive."

Plans of locks and dams have been made in sufficient detail for estimating the cost of improving the river between Minneapolis and St. Paul. I have also prepared new and exact estimates for this work. These estimates have been submitted in a separate special report. The cost of this, including preparation of maps, plans, etc., was $5,431.24.

ST. PAUL TO LAKE PEPIN.

Under projects approved August 9, 1892, and May 8, 1893, work was continued between St. Paul and Lake Pepin by days labor and use of Government plant, the material being secured both by formal contract and by purchase in open market.

Work was resumed June 28, 1893, on dams and shore protections in the vicinity of Nininger and Hastings with the launch *Emily* and a part of the plant. On July 10 the towboat *Fury* and remainder of the plant were moved to the vicinity of Island 1 for work.

In the vicinity of Nininger and Hastings, dams 45 and 46 (sheet 5) and dams 16, 17, 19, 20, 21, 22, 23, 24, and 34 (sheet 6) were built; dams 23, 24, 25 (sheet 5), and 8 (sheet 6) were raised and extended; dams 19, 20, 21, 29, 30 (sheet 5) and 5, 6, 7, 9, 11, 12, 13, 14, 18 (sheet 6) were raised. At the upper end of Island 18, 860 linear feet of shore protection, 37 feet wide, were added to that built in 1892, completing the protection from head of the island to Dam 23 (sheet 5). The shore protection at lower end of Island 16 was raised to top of bank for a distance of 650 feet, and the protections at lower ends of islands 17 and 18 were repaired with rock. The protection of 1889 on right bank above Hastings was continued upstream to Dam 14 (sheet 6), a distance of 2,070 feet, having an average width of 55 feet.

In the vicinity of Island 1, dams 39 and 40 (sheet 1) were built; dams 2, 6, 7, 8, 10, 24 (sheet 1) and 1 (sheet 2) were raised and extended; dams 3, 9, 23, 35, 36, 37, 38 (sheet 1) and 2 (sheet 2) were raised. In the bend at Pigs Eye, right bank, 1,509 linear feet of shore protection, of an average width of 40 feet, were built; 800 feet remain to be built to complete the protection of this bend. The shore protection opposite Island 1 was slightly repaired.

On August 16 towboat *Fury* and plant were moved to Merrimac, where dams and shore protections were constructed and repaired as follows: Dams 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53 (sheet 3) and 50 (sheet 4) were built; dams 10, 11, 12, 21, 22, 23, 24, 34 (sheet 3) and 5 (sheet 4) were raised and extended; dams 8, 13, 14, 19, 25, 33 (sheet 3) were raised. Along the left bank, below Newport, 1,818 linear feet of shore protection were built, completing the protection from Newport to Dam 25 (sheet 3). The shore protection at the head of Island 7 was extended 150

feet to join Dam 34. The shore protections above Robinsons Rocks and above Bend were repaired.

On October 24 the forces were combined at Gery Cloud Island, where the follow works were constructed to prevent the movement of a large body of sand accu lated along the right bank above Island 14 and to improve the channel below; d 51, 52 (sheet 4), 47, 48, 49, 50, 51, 52, and 53 (sheet 5) were built; Dam 42 (sheet 5) raised; the left bank along Grey Cloud Meadow was protected for 2,652 feet upstr from Dam 50 (sheet 5), the average width being 36 feet; the protection of ri bank below Island 14 was continued upstream 437 feet, 40 wide.

Operations for the season were closed November 16, and the entire fleet was l up in the winter harbor at Boulanger Slough.

The prices paid for materials delivered on U. S. barges were as follows: By for contracts made in 1892, rock, per cubic yard, 62 cents; brush, per cubic yard, 32½ 35½ cents; by formal contracts made in 1893, rock, per cubic yard, 54½ cents; bru per cubic yard, 29½ cents; by purchase in open market, where "immediate deliv was required by a public exigency," at contract prices: rock, per cubic yard, cents; brush, per cubic yard, 32½ cents.

At the close of the season 846.8 cubic yards of brush on hand were store Boulanger Slough and Suttons Landing.

Towboat *Fury* was laid up at St. Paul, from June 24 to July 7 inclusive, havin burned boiler sheet replaced; and from August 9 to 20 inclusive, repairing a bro wheel shaft. During the latter delay the steamer *May Libbey* was hired, at $25 day, to do the towing.

Works of improvement should be constructed during the season of 1894 at following places: Shore protection in Pigs Eye Bend; dams at the lower en Stockyards and opposite same; dams in the vicinity of Robinsons Rocks; dams shore protections along Grey Cloud Island, in the vicinity of islands 14 and 15; re to Dam 1 (sheet 5); extension of the series of dams above Hastings; dams and s protections in the vicinity of Island 19, and between Prescott and Island 20.

List of works constructed and repaired and of materials used, during season of between St. Paul and Lake Pepin.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Br
Sheet 1:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu.*
Dam 39	230	4.5	277.2	
Dam 40	130	4.5	213.4	
Shore protection, right bank, above Island 1, extended	1,509	.....	2,017.7	
Dam 2, raised and extended	50	4	344.8	
Dam 3 (closing), raised	.....	4	372.3	.....
Dam 6, raised and extended	70	4	702.8	1,
Dam 7, raised and extended	50	4	347	
Dam 8, end raised and extended	60	4	176	
Dam 9, raised	.....	4	206.8	
Dam 10, end raised and extended	50	4	160	
Dam 23, end raised	.....	4	145.3	....
Dam 24, raised and extended	100	4	387.8	
Dam 35, end raised	.....	4	105.7	....
Dam 36, end raised	.....	4	86.9	....
Dam 37, raised	.....	4	206.7	....
Dam 38, raised	.....	4	167.3	....
Shore protection, opposite Island 1, repaired	.....	.....	60.3	....
Sheet 2:				
Dam 1, raised	160	4	355.9	
Dam 2, end raised	.....	4	75.4	....
Sheet 3:				
Dam 35	215	4.5	243.9	
Dam 36	80	4.5	155.2	
Dam 37	90	4.5	156.1	
Dam 38	135	4.5	231.6	
Dam 39	112	4.5	105.3	
Dam 40	80	4.5	203.3	
Dam 41	465	4	789.4	
Dam 42	555	2.5	729.9	
Dam 43	465	4	656.7	1,
Dam 44	490	4	985.9	1,
Dam 45	497	4	862.4	1,
Dam 46	315	4.5	668.6	
Dam 47	195	5.5	324.3	
Dam 48	80	4.5	183.3	
Dam 49	90	4.5	164.3	
Dam 50	195	4.5	205.4	
Dam 51	510	4	571.3	1,
Dam 52	250		290.9	
Dam 53	300		339.1	

List of works constructed and repaired and of materials used, etc.—Continued.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Brush.
Sheet 3—Continued.	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Shore protection, left bank, below Newport	1,818	.....	1,978.8	1,145.7
Shore protection, Island 7, extended	150	.....	169.9	187.7
Dam 8, end raised	.....	4	86.7	.....
Dam 10, raised and extended, pile dam changed	30	4	780.5	540.8
Dam 11, raised and extended, pile dam changed	50	4	484.5	721.5
Dam 12, raised and extended, pile dam changed	80	4	839	761.2
Dam 13, raised	.....	3	264.8	.....
Dam 14, raised	.....	4	698.8	.....
Dam 19, repaired	.....	.....	73.4	.....
Dam 21, raised and extended	50	4	742.3	401
Dam 22, raised and extended	70	4	365.3	175.1
Dam 23, raised and extended	55	4	296	174.2
Dam 24, raised and extended	60	4	389.5	213.2
Dam 25, raised	.....	4.5	473.9	.....
Dam 33, end raised	.....	4	78	.....
Dam 34, raised and extended back to Island No. 7	160	4	364.2	317.5
Shore protection, left bank, above Robinsons Rocks, repaired	.....	.....	87.5	.....
Sheet 4:				
Dam 50	230	4	239	332.8
Dam 51	690	4	854.2	1,527.2
Dam 52	845	4	609.9	1,312.5
Shore protection, left bank, below Grey Cloud Landing	2,652	.....	3,846	1,670.3
Dam 5, extended	110	4	179.8	572.5
Shore protection, right bank, above Pine Bend, repaired	.....	.....	245.4	.....
Sheet 5:				
Dam 45	165	4	250	408.3
Dam 46	100	4	141.3	74.1
Dam 47	350	4	529	749.6
Dam 48	230	4	347.3	661.9
Dam 49	200	4	688.9	502.3
Dam 50	100	4	184.1	342.1
Dam 51	245	4	395.9	807.1
Dam 52	330	4	558.8	727
Dam 53	70	4	104.2	197.4
Shore protection, left bank, Island 18, extended	860	.....	1,105.5	569.9
Shore protection, right bank, below Island 14, extended	437	.....	457.2	480.1
Dam 10, end raised	.....	.....	136.4	.....
Dam 19, end raised	.....	.....	29.3	.....
Dam 20, end raised	.....	.....	58.6	.....
Dam 21, end raised	.....	.....	19.5	.....
Dam 23, raised and extended	30	4	129.8	208.6
Dam 24, raised and extended	40	4	230.3	180.7
Dam 25, raised and extended	70	4	180	229
Dam 29, end raised	.....	.....	58.7	.....
Dam 30, end raised	.....	.....	53.1	.....
Dam 42, raised and extended	250	4	487	922.1
Shore protection, right bank, Island 16, raised to top of bank	650	.....	318.1	207.4
Shore protection, left bank, Island 17, repaired	.....	.....	524.5	.....
Sheet 6:				
Dam 16	150	4	125.6	440.9
Dam 17	300	4	284.8	597.5
Dam 19	510	4	500.3	1,486.5
Dam 20	600	4	484	1,530.2
Dam 21	545	4	372.9	1,177.5
Dam 22	500	4	472.6	1,233.6
Dam 23	425	4	583.5	1,166.1
Dam 24	330	4	434.7	798.3
Dam 34	675	4	1,133.9	2,019.6
Shore protection, right bank, above Hastings	2,070	4	4,169.4	1,376.6
Dam 5, raised	.....	4	454.7	.....
Dam 6, raised	.....	4	728.8	.....
Dam 7, raised	.....	4	516.9	.....
Dam 8, raised and extended	60	4	847.5	392.6
Dam 9, raised	.....	4	457.9	.....
Dam 10, raised	.....	4	139.7	.....
Dam 11, raised	.....	4	242.8	.....
Dam 12, raised	.....	4	143.1	.....
Dam 13, raised	.....	4	165.2	.....
Dam 14, raised	.....	4	77.8	.....
Dam 18, raised	.....	4	512.2	.....
Shore protection, left bank, Island 18, repaired	.....	.....	487.6	.....
Total	.....	.....	48,717.6	46,143.8

Financial statement for work of improving the Mississippi River between St. P Lake Pepin during the season of 1893.

Amount expended in field during the calendar year 1893, deducting $1,057.62 liabilities outstanding December 31, 1892 (from distribution sheets)		$67,
Add cost of material from 1892		
Add retained percentage on contracts		
		69,
Deduct retained percentage of 1892	$113.56	
Deduct cost of material on hand at close of season	249.81	
Net cost of field work		69,
Add quota of general superintendence and office expenses		1,
Add for use and deterioration of plant		3,
Total		74,
Materials put in works:		
Rock ..... cubic yards		48,
Brush ..... do		46,
Total ..... do		94,
Average cost of cubic yard—		
On barges		
For towing and putting in material		
For general superintendence and office expenses		
For plant		
Average cost per cubic yard in place		

To Mr. J. S. Whiting, overseer, in immediate charge, is due much credit for ful and conscientious management of this work.

SMITHS BAR TO LAKE PEPIN.

Under project approved May 8, 1893, and allotment of $50,000, a contract August 8, 1893, was entered into with Jacob Richtman for the construction of protections between Smiths Bar and Lake Pepin, at $1.20 per cubic yard for r place and 40 cents per cubic yard for brush in place.

Work was commenced July 31, 1893, below Smiths Bar, where 2,672 linear shore protection were built along the right bank, extending downstream fro protection of 1879 (sheet 8); the average width is 48 feet, and the average thi of rock is 1 foot. Slight repairs were made to the old protection.

August 28 the plant was moved to a point about 2 miles above Diamond Bluff, 4,283 linear feet of shore protection were constructed along the right ban average width is 58 feet, and average thickness of rock is 1.3 feet. Along t bank below Morgans Coulee 1,300 linear feet of shore protection were constr extending downstream from the protection of 1889; the average width is 4 and average thickness of rock is 1.2 feet.

Operations were discontinued October 20, to be resumed in 1894.

Shore protection in the vicinity of Red Wing should be constructed duri season of 1894.

Mr. G. C. Saulez, inspector, gave this work excellent supervision.

List of works constructed and repaired, and of materials used, during the season o under contract with Jacob Richtman, between Smiths Bar and Lake Pepin.

Designation.	Length.	Materia	
		Rock.	
Sheet 8:	*Feet.*	*Cu. yds.*	C
Shore protection, right bank, Smiths Bar	2,672	5,162.6	
Shore protection, right bank, repaired		118.2	
Sheet 9:			
Shore protection, right bank, above Diamond Bluff	4,283	11,859.6	
Shore protection, left bank, below Morgans Coulee	1,300	2,419.5	
Total		19,559.9	1

Financial statement for work between Smiths Bar and Lake Pepin, performed under contract during season of 1893.

Amount paid contractor		$25,596.87
Add retained percentage		2,844.09
Add cost of local inspection		586.38
Add quota of general superintendence and office expenses		743.04
Total		29,770.38
Materials put in works:		
Rock	cubic yards	19,559.9
Brush	do	12,422.7
Total	do	31,982.6
Average cost per cubic yard in place		$0.931

SURVEYS.

In connection with the works of improvement, surveys were made at Merrimac, Robinsons Rocks, Grey Cloud Landing, and above Hastings. At Island 23 a survey was made to determine the practicability of improving the left branch of the river at that point.

Permanent monuments were located at 37 points between St. Paul and Prescott, and the azimuth of the lines connecting them observed. These monuments, excepting monument K, opposite Island 1, were given consecutive numbers, No. 1 at St. Paul and No. 36 at Prescott. Excepting Nos. 1, 13, and 33, the monuments were cut from Nininger stone; size, 8 inches square at top, 10 inches square at base, and about 30 inches long; they are centered with a small hole, and set with top at or a little above surface of ground. Monument No. 1 is cut in top of coping stone of the Broadway sewer; No. 13 is the top of an iron bolt leaded into the top of ledge of rock at Merrimac Landing; No. 33 is cut in top of ledge of rock at Hastings Landing. Two monuments were set at Island 23.

Levels were taken to connect with the permanent bench marks of the Mississippi River Commission in the vicinity of St. Paul, Island No. 18, Franklins Coulee, below Prescott, and at Smiths Bar.

Mr. H. E. Clark was in immediate charge of surveys and did excellent work.

I would suggest that a survey of the river from Prescott to Lake Pepin be made during 1894.

Very respectfully, your obedient servant,

J. D. DuSHANE,
Superintendent.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. W. A. THOMPSON, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., February 10, 1894.

MAJOR: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1893:

REEDS LANDING TO MINNEISKA.

Work in this locality, consisting of the construction and repair of brush and rock dams and shore protections, was carried on in continuation of contract with Jacob Richtman, commenced in 1892, under approved project of August 9, 1892, from appropriation of July 13, 1892. The prices paid for material in place were as follows: Rock, $1.53 per cubic yard; brush, 54 cents per cubic yard.

During the season of 1893 work was carried on in vicinity of Pine Island, below Alma, and near Tee-pee-ota Point. The contractor was granted authority to carry on operations during the winter, there being several dams to be built on dry bars and in very shoal water, where such work could be advantageously carried on. Material was hauled to the dams by teams until the ice disappeared, when boats and barges were put into use.

Completion of Dam 15 (sheet 15) commenced December 28, 1892, was the first work undertaken.

Five wing dams, 800 feet apart, and numbered, respectively, 15, 16, 18, 19, and 20 (sheet 15), were built from the west shore of Island 41, the lowest one of the series—Dam 15—being located 800 feet above Closing Dam 14, which closes chute between Island 41 and Pine Island. Closing Dam 14 received some slight repairs.

Two wing dams were built from the west shore of Island 41, below Closing Dam 14. The first, Dam 17, is 800 feet below Dam 14, and the second, Dam 21, is 1,600 feet below Dam 14.

Work below Alma was discontinued June 12, and the fleet taken to vicinity of Teepee-ota Point, where construction of Wing Dam 33 (sheet 14), between old Wing Dams 9 and 10, was commenced. Dam 33 is 840 feet below Dam 10 and parallel to it. It was completed July 1, and fleet returned to vicinity of Pine Island, where the construction of two submerged wing dams from right bank was commenced. The upper one, Dam 22 (sheet 15), is located 1,250 feet above E. Lehman's dwelling, and the lower one, Dam 23, is 1,300 feet below Dam 22. Both dams were completed.

During the time that the submerged dams were under construction, Dams 16, 17, 18, 19, 20, and 21 (sheet 15) were raised, leveled, and trimmed.

Operations were suspended July 28, 1893, the contract being completed.

Mr. Louis Shaw and Mr. E. H. Kaulfuss were the local inspectors.

List of works constructed and of materials used during season of 1893, under contract with Jacob Richtman, between Reeds Landing and Minneiska.

Designation.	Dimensions.		Material.	
	Length.	Height referred to, low water 1864.	Rock.	Brush.
Sheet 14:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Wing dam 33	1,150	+3	1,752.9	3,778
Sheet 15:				
Closing dam 14, repaired			11.9	
Wing dam 15	1,080	+4	1,549.1	1,984.9
Wing dam 16	990	+4	1,523.8	2,888.3
Wing dam 17	770	+4	1,224.6	2,696.2
Wing dam 18	700	+4	1,261.9	2,283.3
Wing dam 19	390	+4	1,505.9	2,293.7
Wing dam 20	185	+4	1,027.6	1,418.1
Wing dam 21	290	+4	2,402.9	3,162.1
Wing dam 22	140	—6	343.9	476
Wing dam 23	350	—6	592.8	806.1
Total	6,045	.....	13,197.3	21,795.7

Financial statement for work between Reeds Landing and Minneiska, performed under contract in 1892 and 1893.

Amount paid contractor	$44,644.91
Cost of local inspection, etc	1,641.75
Add quota of general superintendence and office expenses	1,492.52
Total	47,779.18
Material put in works, 1892 and 1893:	
Rock ..... cubic yards	19,452.3
Brush ..... do	27,560.9
Total ..... do	47,013.2
Average cost per cubic yard in place	$1.016

MINNEISKA TO GENOA.

The improvement of this section of the river—74 miles in length—by construction of dams and shore projections, was carried on under projects approved August 9, 1892, May 8, 1893, and September 19, 1893. Work during the season was performed by hired labor and use of Government plant, towboat *Alert* and launches *Ada* and *Elsie* being used for towing.

Material, loaded on United States barges, was purchased as follows:

Under formal written contract.—Sand rock at 50 and 53 cents per cubic yard; brush at 24½ and 30½ cents per cubic yard.

open market.—Lime rock at 60 cents per cubic yard; brush at 24, 24½, and 27 ts per cubic yard; 4,049.6 cubic yards brush, left on hand at close of season of , were put into the work during season of 1893.

ontracts for furnishing material were all completed, with the exception of one h Albert Kirchner, of Fountain City, Wis., for furnishing rock, dated August 1893.

'ork during the season was carried on principally between La Crosse and Brownse and in vicinity of Hammond Chute and Chimney Rock.

ince the commencement of general improvements in 1878 very little work has n done heretofore between La Crosse and Brownsville. In 1883 Broken Arrow igh, Crosby Slough, and Swift Slough were closed. During the past season rations have been carried on in the following localities: At Grand Crossing; at sing between foot of Broken Arrow Island and head of Island 112; at crossing n head of Island 112 to mouth of Root River; at the bar above Island 115; at nd 116, and opposite Brownsville. The commencement of operations was somet delayed by high water and work was not begun until May 6, 1893, when the ; was taken to Wisconsin shore, below Isle La Plume, and the construction of a es of wing dams from left bank was inaugurated, with a view to contracting and ening channel in vicinity of Broken Arrow Island. La Plume Chute and Sand igh were closed. Three wing dams from west side of La Plume Island (108) and n wing dams from Wisconsin shore, between foot of La Plume Island and head Island 112, were constructed. One wing dam was built from west shore of nd 112, and the shore of same island was protected for a distance of 3,570 feet. e shore protection will require more rock. Six wing dams were built from Minta shore, between foot of Broken Arrow Island and mouth of Root River. ee wing dams were built from west side of lower end of Island 112 and nine wing s from east shore between foot of Island 112 and chute of Island 113. This te was closed, and shore of island below chute was protected for a distance of 0 feet. Four wing dams were constructed from Minnesota shore between foot of tyune Island and head of Island 115. The chute of Island 115 was closed. One g dam was built from east shore above head of Island 117 and six wing dams n west side of same island. The cut-off in Island 117 was closed. Two cut-offs sland 116, both running into Swift Slough, were closed and three wing dams were lt from east side of Island 116. Three hundred and eighty feet of shore protec- were constructed on lower east side of Island 116.

onsiderable trouble was experienced by navigators during July and August in nity of Hammond Chute, and on August 31 a part of the fleet which had been loyed below La Crosse was taken to Island 90, above Dakota, and the work of tecting Island 90 and closing slough on west side of same was commenced. This e protection, 280 feet in length, and Closing dam 13 (sheet 20) were completed tember 13, and resulted in effectually improving the crossing at Hammond Chute. trouble was experienced at this point during remainder of season.

he fleet used at Island 90 was taken to vicinity of Chimney Rock, where the r has for several years been unfavorable for raft navigation. Heretofore the nnel has been on the Wisconsin side of the river. By the construction of a series ving dams from Wisconsin shore it was proposed to decrease the width of the r about two- thirds at this point, which would cause an increased flow of water n the Minnesota shore and establish a permanent channel about 800 feet wide on side of the river. To facilitate the opening of this channel, dredge *Phœnix* was loyed from August 22 to October 15 in cutting a passage through the bar. The ations of dredge *Phœnix* are given further on. Two wing dams from Wisconsin e above Island 52, and two wing dams from west side of Island 52, 50 and 1,050 respectively, below head of island, were constructed, and the slough east of s was closed. One wing dam was built from west shore of Island 53, 225 feet w the head. Owing to the lateness of the season these dams were not completed, the work accomplished proved very beneficial. Operations at Chimney Rock s suspended November 4, and the fleet stored in Fountain City Bay.

n November 2 the fleet employed below La Crosse was moved to East Channel for purpose of repairing shore protection at Island 98, and Closing Dam 17 (sheet 21). k in this locality was discontinued November 4, and the fleet laid up for the ter in Black River at La Crosse.

vo thousand two hundred and eighty-four and five-tenths cubic yards of brush left on hand at close of season, which have been stored on Schusters Island in ntain City Bay.

e locations of the works referred to are shown on the map of survey of this of the river, made in 1893, and their dimensions are given in the following :

List of works constructed and repaired, and of materials used, during the season of between Minneiska and Genoa.

Designation.	Dimensions.		Material	
	Length.	Height above low water, 1864.	Rock.	Br
	Feet.	*Feet.*	*Cu. yds.*	*Cu*
Sheet 22:				
Wing dam 4	680	3	454.5	2
Wing dam 5	940	3	435.8	2
Wing dam 6	900	3	355.8	1
Wing dam 7	720	3	586.6	3
Wing dam 8	550	3	383.4	2
Wing dam 9	680	3	634.4	3
Wing dam 10	950	3	572.5	2
Wing dam 11	750	3	197.2	1
Wing dam 12	800	3	378.4	
Wing dam 13	650	3	287.2	1
Wing dam 14	650	3	528.5	1
Wing dam 15	780	3	368.4	1
Wing dam 16	610	3	473.9	2
Wing dam 17	560	3	565.9	1
Wing dam 18	500	3	806.5	3
Wing dam 19	440	3	655.9	1
Wing dam 20	600	3	1,380.2	5
Wing dam 21	480	3	1,076.5	3
Wing dam 22	52[illegible]	3	1,063.6	4
Closing dam 23	760	3	750.5	2
Wing dam 24	735	3	716	2
Wing dam 25	580	3	984.4	3
Wing dam 26	600	3	983	4
Wing dam 27	700	3	711.5	2
Wing dam 28	880	3	476.5	1
Wing dam 29	920	3	662	1
Wing dam 30	330	3	1,106.5	5
Wing dam 31	120	3	344.9	1
Closing dam 32	650	4	258.4	
Wing dam 33	530	3	420.5	2
Wing dam 34	270	3	332.2	
Wing dam 35	300	3	636.2	3
Closing dam 36	110	4	151.7	....
Wing dam 37	660	3	307.9	1
Wing dam 38	1,100	3	705.3	2
Wing dam 39	730	3	1,309.3	4
Wing dam 40	630	3	1,201.1	4
Closing dam 41	450	4	588.3	1
Wing dam 42	260	3	356.5	1
Wing dam 43	1,050	3	1,158.7	5
Wing dam 44	750	3	1,313.6	4
Wing dam 45	580	3	1,401.5	5
Wing dam 46	450	3	1,222.1	4
Closing dam 47	70	4	85.3	
Closing dam 48	170	4	272	
Wing dam 49	100	3	514.8	1
Wing dam 50	170	3	816.4	
Wing dam 51	400	3	266.1	
Wing dam 52	850	3	177.8	1
Shore protection, Island 112	3,570	.....	4,455.3	6
Shore protection, Island 113	2,530	.....	2,328.1	4
Shore protection, Island 116	380	.....	357.7	
Sheet 21:				
Closing dam 17 repaired	.....	4	273.3	
Closing dam 41	420	7	331.7	4
Shore protection, Island 98, repaired	.....	.....	456.3	
Sheet 20:				
Closing dam 13	990	4	970.8	3
Shore protection, Island 90	280	.....	316.2	
Sheet 16:				
Wing dam 11	985	4	1,354.7	4
Wing dam 12	200	4	317.5	
Wing dam 13	1,650	4	2,379.5	1
Wing dam 14	50	4	490.2	
Wing dam 15	750	4	339.7	
Closing dam 16	300	4	422	
Total	.....	.....	47,290.4	17

Financial statement for work between Minneiska and Genoa, performed by hired labor during season of 1893.

Amount expended in the field during calendar year 1893 (from distribution sheets)		$121,436.49
Less liabilities outstanding December 31, 1892	$2,491.18	
Less cost of material on hand	559.70	
		3,050.88
		118,385.61
Add cost of material on hand January 1, 1893		890.91
Add retained percentage (Kirchner contract)		372.82
Net cost of field work		119,649.34
Add quota of general superintendence and office expenses		3,054.54
Add for use and deterioration of plant		6,477.81
Total		129,181.69
Material put in works:		
Rock	cubic yards..	47,290.4
Brush	do....	176,289.2
Total	do....	223,579.6
Average cost per cubic yard—		
On barges		$0.322
For towing and putting in place		.213
For general superintendence and office expenses		.014
For plant		.029
Average cost per cubic yard in place		.578

GENOA TO PRAIRIE DU CHIEN.

Work in this locality was carried on under two contracts.

First contract.—Under project of August 9, 1892, and allotment of $50,000, a contract, dated October 11, 1892, was entered into with Albert Kirchner for construction of brush and rock dams and shore protections, at $1.40 per cubic yard for rock in place and 66 cents per cubic yard for brush in place. Operations were commenced April 18 and discontinued September 2, 1893, upon completion of contract. Work was carried on near Island 126, about 1 mile below Genoa, and at islands 132 and 135, below Bad Axe Bend. Eight wing dams, three closing dams, and one piece of shore protection were constructed, as follows: Closing dam 1 (sheet 24), across chute east of Island 126; five wing dams—Nos. 2, 3, 4, 5, and 9—from Minnesota shore, opposite and above upper end of Island 126; three wing dams—6, 7, and 8—from Wisconsin shore above head of Island 126; 3,050 feet of shore protection around head and down west side of Island 126; Closing dam 10, across chute between islands 132 and 135, and Closing dam 11, from upper end of Island 135 to Minnesota shore, across slough known as Lost Channel. Contract with Albert Kirchner closed before the completion of Closing dam 10, but the dam was subsequently finished under contract with Bigelow & Teasdale.

The construction of dams and shore protection in vicinity of Genoa resulted in deepening the channel on bar formed near the head and opposite the west side of Island 126.

List of works constructed and of materials used during season of 1893, under contract with Albert Kirchner, between Genoa and Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 24:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Closing dam 1	460	4	3,160.9	3,842.8
Wing dam 2	857	4	1,796.7	2,134.3
Wing dam 3	804	4	1,429.4	1,715.5
Wing dam 4	750	4	1,618.7	1,490.9
Wing dam 5	500	4	944.1	980.9
Wing dam 6	265	4	1,458.1	2,008.3
Wing dam 7	465	4	1,845.7	2,276.7
Wing dam 8	500	4	2,279.7	2,401.7
Wing dam 9	300	4	894.2	486.5
Closing dam 10, commenced	445	1	2,137.4	3,098.4
Closing dam 11	607	4	736.8	1,109.1
Shore protection, Island 126	3,050	.....	4,050.6	5,052.7
Total materials put in works	.....	.....	22,092.3	24,585.8

Financial statement for work between Genoa and Prairie du Chien, performed under contract with Albert Kirchner during season of 1893.

Amount paid contractor		$47,155.85
Cost of local inspection, etc		1,260.02
Add quota of general superintendence and office expenses		1,239.45
Add plant charge		53.83
Total		49,709.15
Material put in works:		
Rock	cubic yards..	22,092.3
Brush	do....	24,585.8
Total	do....	46,678.1
Average cost per cubic yard in place		$1.065

Second contract.—Under project of May 8, 1893, and allotment of $50,000, a contract, dated August 7, 1893, was entered into with Bigelow & Teasdale for the construction of brush and rock dams and shore protections, at $1.14 per cubic yard for rock in place and 40 cents per cubic yard for brush in place. Operations were ommenced August 18 and carried on until the close of navigation, November 14. During this time one closing dam, two wing dams, and 8,740 feet of shore protection were constructed; and Closing dam 10 (sheet 24), which was commenced under the Kirchner contract, was completed to a height of 4 feet above low water of 1864.

The works accomplished are as follows: 3,980 linear feet of shore protection on Minnesota shore opposite Island 126, beginning at a point 2,500 feet below Dam 9 and extending down the Minnesota shore; 600 linear feet of shore protection on Island 128, extending around the head and down the east bank; 3,240 linear feet of shore protection on Wisconsin shore, beginning at a point 750 feet below foot of Island 128 and running down stream; 920 linear feet of shore protection on right bank of river, beginning at a point 1,100 feet below foot of Island 129 and running down stream; Closing dam 12, from west bank of Island 128 to Minnesota shore, and wing dams 13 and 14, from Minnesota shore above head of Island 128. Closing dam 10, commenced under the Kirchner contract, was completed. The object of these works is to straighten and improve the channel at Island 128 and at Bad Axe Bend. The work accomplished has already been productive of good results.

It is respectfully suggested that shore protection below foot of Island 129 be extended down the river about 2,000 feet, and that three wing dams be constructed in vicinity of Island 131, with a view to further improving the channel at Bad Axe Bend.

Mr. C. A. Stoddard was the inspector in local charge of the work under both contracts.

of works constructed and of materials used during season of 1893, under contract with Bigelow & Teasdale, between Genoa and Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
et 24:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Shore protection on Minnesota shore, opposite Island 126.	3,980	.....	4,920.4	4,354
Closing dam 10, raised	.....	4	1,151.2	1,426.2
Closing dam 12	460	4	2,473.7	3,811.1
Wing dam 13	275	4	1,462.8	2,518.7
Wing dam 14	385	4	2,446.7	4,298.3
Shore protection, Island 128	600	.....	836.9	695.3
Shore protection on Wisconsin shore, below Island 128..	3,240	.....	5,366.9	4,225.9
Shore protection on right bank, below Island 129.....	920	.....	1,847.9	1,127.5
Total	.....	.....	20,506.5	22,457

ancial statement for work between Genoa and Prairie du Chien, performed under contract with Bigelow & Teasdale during the season of 1893.

mount paid contractor	$29,124.20
etained percentage	3,236.02
ost of local inspection, etc	863.49
dd quota of general superintendence and office expenses	850.54
dd plant charge	53.84
Total	34,128.09
aterial put in works:	
Rock, cubic yards	20,506.5
Brush, do	22,457
Total, do	42,963.5
verage cost per cubic yard in place	$0.794

DREDGING AT CHIMNEY ROCK.

The bar in the vicinity of Chimney Rock has for many years made navigation at hat point dangerous and difficult. The river being very wide in this locality, it as decided to construct a series of wing dams from the east shore for the purpose f forcing the water down the Minnesota or west shore of the river. The details elating to the construction of these dams are given in another part of my report.

To facilitate the formation of a channel at this point, dredging through the bar as considered the surest and best method of producing the desired results.

On August 8, 1893, dredge *Phœnix* and three dump boats were taken in tow at Keithsburg by the snag boat *General Barnard* and brought to Chimney Rock. On August 19 and 20 a cut was made through the bar between Islands 76 and 77, about 3 miles above Trempealeau. On August 22 the dredge arrived at Chimney Rock, and dredging through the bar along the Minnesota shore was commenced. The towboat *J. W. Mills* was chartered as a tender for the dredge. Most of the material dredged was "cast" and carried away by the increased velocity of the current. The cut through the bar was successfully made, thereby establishing a channel on the Minnesota side, the permanency of which channel, it is expected, will be secured by the construction of the above-mentioned wing dams from the Wisconsin shore.

Operations were discontinued October 16, and the dredge and three dump boats left for Keokuk in tow of the *J. W. Mills*, arriving there on October 23. The *J. W. Mills* then returned to Le Claire, Iowa, and went out of commission.

The cost of the above-mentioned dredging was $8,006.35.

SURVEYS.

A party in charge of Mr. Louis Shaw was put in the field July 12, 1893, and was engaged until November 15 on surveys of the river between Minneiska and Lynxville. An excellent detailed survey was made from Minneiska to Crooked Slough, a distance of about 100 miles as measured on the low-water channel. Several addi-

tional detached and duplicate examinations were made during the season, aggregating in length about 25 miles. The maps are now being platted in the office at Rock Island and will soon be completed.

The cost of these surveys will aggregate about $6,000.

Respectfully submitted.

W. A. THOMPSON,
Superintendent.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. J. C. M'ELHERNE, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 23, 1894.

MAJOR: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1893:

GLENHAVEN TO DUBUQUE.

Under project approved August 9, 1892, and allotment of $50,000, a contract, dated October 3, 1892, was entered into with A. J. Whitney for the construction of dams and shore protections of rock and brush, at 59 cents per cubic yard for brush and $1.40 per cubic yard for rock in place.

No work was done during season of 1892, and the time for the completion of contract was extended to December 1, 1893.

Active operations were commenced June 15, 1893, and continued without interruption until the completion of the contract, October 28. Mr. Isaac Mathewson was local inspector from June 15 until August 26, and Mr. A. J. Stibolt from August 26 until the close of work. Both performed the duties assigned them in a very satisfactory manner.

The work accomplished consisted in the construction of two wing dams and three closing dams, and shore protections on Islands 219, 220, 221, and 222. The above work was performed with the view of improving the bad crossing above Kimbels Landing, which was one of the worst obstructions to navigation in 1891. The work of improvement at Parsons Bar was inaugurated by closing, at its head, the small chute behind Island 215, and protecting the shores of Islands 213 and 214.

List of works constructed and of materials used during the season of 1893 between Glenhaven and Dubuque.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 35:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 1, closing	180	5	695	747.4
Shore protection on Island 213	1,797	.....	2,526.8	2,282.2
Sheet 36:				
Dam 1, closing	983	4	2,179.4	1,784.3
Dam 2, closing	740	4	2,863.9	2,609
Dam 3, closing	720	5	2,812.6	3,215.2
Dam 4, wing	760	4	3,365.1	3,537.6
Dam 5, wing	527	.....	1,816.8	1,624.3
Shore protection on Island 219	2,115	.....	3,391.7	3,050.3
Shore protection on Island 220	825	.....	2,508.1	1,564
Shore protection on Island 221	230	.....	590	270
Shore protection on Island 222	709	.....	1,860.6	923.2
Total	.....	.....	24,619	21,167.5

Financial statement for work between Glenhaven and Dubuque performed under contract during season of 1893.

Amount paid contractor	$46,907.42
Cost of local inspection, etc	1,298.30
Add quota of general superintendence and office expenses	1,234.07
Add for use and deterioration of plant	42.66
Total	49,482.45

erial put in works:

Rock	cubic yards..	24,610
Brush	do....	21,107.5
Total	do....	45,717.5
rage cost per cubic yard in place		$1.082

DUBUQUE TO CLINTON.

Under project approved August 9, 1892, and allotment of $50,000, a contract, dated tober 8, 1892, was entered into with Patterson Bros. for the construction of brush d rock dams and shore protections, at 59 cents per cubic yard for brush in place d $1.40 per cubic yard for rock in place.

Only a part of the contract having been worked out in 1892, the time for comple- on was extended to December 1, 1893. Operations were resumed June 15, 1893, and rogressed satisfactorily until the completion of the contract, September 26.

Mr. A. J. Stibolt was local inspector from June 15 to August 26, and Mr. Edward L. Sisson from August 26 until the completion of the contract. The duties con- ected with the work were discharged by both in a very efficient manner.

For the purpose of improving the crossing at Four Mile Island (228), 3 wing dams nd 1 closing dam were constructed. The closing dam runs from Island 228 to Island 29, and the wing dams project from the shore of Island 230. A short piece of shore rotection was built on Island 230 below Dam 5 (sheet 37). This was one of the orst places in 1891, and continued bad in 1892. Good results were secured by the ork carried out.

The chute of Nine Mile Island (232), which diverted considerable water from the ain channel, was closed, two dams being built for the purpose, one running from e Iowa shore to the tow-head, and the other from the tow-head to Nine Mile Island.

t of works constructed and of materials used during the season of 1893 between Dubuque and Clinton.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
et 37:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 1, closing	1,800	4	8,378.6	5,103
Dam 2, closing	675	5	881.8	839.6
Dam 3, closing	435	5	1,207.9	1,099.8
Dam 4, wing	1,307	4	4,733.5	4,524.5
Dam 5, wing	1,050	4	4,879.4	4,791.2
Dam 6, wing, not completed	745	.....	1,854.2	1,472.9
Shore protection below Dam 5	360	.....	925	650
Total	.....	.....	22,860.4	18,481

nancial statement for work between Dubuque and Clinton, performed under contract during seasons of 1892 and 1893.

nount paid contractor	$48,044.75
st of local inspection, etc	1,375.71
ld quota of general superintendence and office expenses	1,424.17
ld for use and deterioration of plant	32.19
Total	50,876.82

terial put in works:

Rock	cubic yards..	25,607.0
Brush	do....	20,669.4
Total	do....	46,276.4
erage cost per cubic yard in place		$1.099

IMPROVING ROCK ISLAND RAPIDS.

The fleet having been first thoroughly repaired was towed to East Moli May 4, 1893, and operations immediately begun in that vicinity.

Dams.—For the purpose of confining the river to narrower limits, and thereby ing a greater depth of water over Duck Creek Chain—especially during low st Wing dam 11 (sheet 47), in accordance with the plan contemplated in the pr was built outward the proposed distance from the Illinois shore at the head chain. The construction of the proposed trailing dam from the outer end o wing dam downstream was temporarily deferred, in order to more thoro observe the effect produced by the main dam itself. In the meantime Wing was run out from an opposite point on the Iowa shore to Duck Creek Chain head. At this juncture the stage at head of chain was 2.1 feet, while at S and at the Rock Island bridge the gauges read 0.4 and 0.9 feet, respectively assist in gaining at foot of chain a portion of the increase thus acquired at the Wing dam 10 was run out from the Iowa shore nearly to the edge of the chan that place. Later on Wing dam 3, at head of Campbells Chain, was ext 350 feet across a deep chute there, and two newly made narrow gaps cut be small towheads at head of Campbells Island, on channel side and on line cofferdam, were eventually closed.

Paving the dams.—On August 8, the river having fallen sufficiently to insure factory proceedings, the paving was commenced and vigorously prosecuted w large force of men until the advent of cold weather prevented further operati the water. The method adopted was to firmly sink two parallel rows of curb to 8 inches in thickness and 2 to 2½ feet in depth, down into the top of each throughout its entire length, and also single rows of similar dimensions int lower edges of the upper and downstream slopes, just below the water surfa foundations, and then pave the intermediate spaces with large-sized riprap set up on edge, from 8 to 12 inches deep. In this manner dams 6½ and 8, after r ing additional rock where needed for raising and leveling purposes, and dams and 11 were carefully covered with pavement to a width of 9 feet on the cre Dam 8, and 8 feet for the others, rounding down into a batter of 2½ to 1 for the ing sides. The top rows of curbing on Closing dam 8 were placed 6 feet apa provide a wagon way, and those of the other dams were placed 2½ feet apart well over, however, toward the upstream side, so as to better resist the pressur

Rock excavation.—Under this head, drilling operations were commenced an cessfully carried on by one boat at a much higher stage of water than heret and later in the season by a second boat, newly built for the service. Both were provided with two crews, each putting in eight hours of actual work per

On June 5 drill boat 103 was set in on high patch of rock below Buoy 22 on Il side of channel, at foot of Duck Creek Chain, so as to flatten out the very curvature there and provide an easier and more secure passage for boats. An 460 by 100 feet, sufficiently covering the outer limits of the obstruction, was car sounded, and the inclosed patch itself worked over by August 5. The widely tered remaining projections of rock, midway up Moline Chain, were after treated in like manner.

Between August 17 and September 23 the high patch of rock found within an of 360 by 100 feet, in center of channel below foot of Moline Chain, and whic been long complained of, was effectually shattered. During the latter period days were spent blasting on high point of reef at north side of Lower Chain owing to the shoalness of water work on this was abandoned to await a higher

From September 23 to November 2 very successful headway was made on the and dangerous reefs in bend at north side of Winnebago Chain. With a vi reducing the long shoulder and thereby widening and straightening the chan that place a beginning was made at the southwest corner, and an area 390 feet by 128 feet wide was examined and subjected to blasting, wherever required, i usual careful way.

The new drill boat (No. 6) arrived from Keokuk on October 4, and was start at the southwest corner of Upper Chain. Here an extensive high and rough bottom, varying from a few tenths of a foot to 1½ feet or more above grade, ext from Illinois side of cut far over into the steamboat channel at that place. A water stages all boats were compelled to go around this, sometimes with great culty, and while doing so frequently got aground. To entirely remove this im ment, and thereby straighten the channel, a line of range poles was set up cl the established buoys, thus defining east edge of cut, and the lower end was worked over for an area 272 feet long by 200 feet wide.

Dredging.—On June 26 the dredge *Phœnix* was put at work at lower end of t abandoned dike, above Moline, for the purpose of removing it, so that rafts mig permitted to more readily pass over that locality into the pool. After working five days she was compelled to quit, owing to rapid fall in river, but was without

nployed at excavating the débris at foot of Duck Creek Chain. She proved to be nsuitable, however, for rock work, and was taken away on July 15 and replaced y dredge *Ajax*. This boat carefully dredged over the area prepared by the drill boat t this chain, as also the large center patch in channel below Moline Chain, and made onsiderable progress on scattering patches in Moline Chain proper, but did not quite ucceed in finishing at the latter place before shutting down. Immense quantities f bowlders and loose rock were met with in and around these patches, and were, of ourse, removed with what had been recently blasted. All the material obtained by reging, being generally of large size and much heavier than the rock received from the quarries, was utilized to great advantage in the construction of the piers and dams.

Guide piers.—This class of work was begun August 12, and carried on at intervals, whenever suitable material could be obtained, but was finally pushed forward with all possible dispatch in order that the piers commenced might be finished before close of season.

Three new piers were constructed, No. 20, on outer end of Wing Dam 10, at foot of Duck Creek Chain; No. 21, on upper side of Moline Crossing; and No. 24, at north side of Lower Chain, above Buoy 26. They were very substantially built up to high-water elevation, their average height being 17 feet; area of base, 40 by 82 feet; area of foundation, 70 by 112 feet. The upper courses of Pier 5, having sustained some injury on account of the settling of the foundation and core, were taken down and replaced in cement after the interior had been compactly filled. The foundations of piers 7, 8, 9, 10, and 12 were repaired wherever the action of the ice and high water had worn away the material.

Operations were discontinued for the season November 2, the employés paid off, and the fleet laid up in Moline Pool in charge of a watchman.

Details of operations.

Launch *Freddie:*	
Hours working	1,603
Miles run light	1,419
Miles run towing	5,861
Miles run, total	7,280
Launch *Louise:*	
Hours working	1,324
Miles run light	1,781
Miles run towing	1,946
Miles run, total	3,727
Drill boat *No. 6:*	
Hours working	334
Hours lost owing to rafts	9
Hours lost owing to accidents	5
Hours lost owing to storms	20
Holes drilled	601
Holes blasted	579
Linear feet of holes drilled	1,912
Range poles set in rock bottom	22
Ringbolts set	3
Solid cubic yards of rock blasted	625
Pounds of dynamite used	1,228
Drill boat *No. 108:*	
Hours working	1,965
Hours lost owing to rafts	63
Hours lost owing to accidents	12
Hours lost owing to storms	32
Holes drilled	4,449
Holes blasted	4,254
Linear feet of holes drilled	13,233
Range poles set in rock bottom	188
Ringbolts set	16
Solid cubic yards of rock blasted	4,002
Pounds of dynamite used	9,545
Dredge *Phœnix:*	
Hours working	110
Hours lost owing to rafts	1
Hours lost owing to accidents	15
Hours lost owing to storms	0
Solid cubic yards of rock dredged and removed	230
Cubic yards loose rock and bowlders dredged and removed	396

Dredge *Ajax:*

Hours working	668
Hours lost owing to rafts	10
Hours lost owing to accidents	26
Hours lost owing to storms	0
Solid cubic yards of rock dredged and removed	2,689
Cubic yards loose rock and bowlders dredged and removed	3,199

Summary of total amounts of material.

Solid cubic yards of rock blasted	4,627
Solid cubic yards of rock dredged and removed	2,919
Cubic yards loose rock and bowlders dredged and removed	3,595

Cost of rock excavation, including charge for use and deterioration of plant.

Locality.	Rock excavated (solid cubic yards).	Total cost.	Average cost per solid cubic yard.
Center patch below Moline Chain, removed	801.4		
Moline Chain, removed	161		
Duck Creek Chain, removed	1,956.6		
Total	2,919	$13,748.49	$4.71
Lower Chain, blasted only	75		
Moline Chain, blasted only	25		
Winnebago Chain, blasted only	975		
Upper Chain, blasted only	632.5		
Total	1,707.5	5,242.03	3.07
Grand total	4,626.5	18,990.52	

Cost of building new piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Average cost per cubic yard.
Slope-wall stone	832.2	$3,952.95	$4.750
Riprap stone	4,025.5	4,202.62	1.044
Total	4,857.7	8,155.57	

Cost of building one pier $2,718.52

Cost of repairs to old piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Average cost per cubic yard.
Slope-wall stone	4	$18.95	$4.738
Riprap stone	614.6	641.64	1.044
Total	618.6	660.59	

List of dams, and of materials used in their construction in 1893.

	Total length.	Riprap.	Paving.		
			Slope wall.	Riprap.	Total.
Sheet 47:	*Feet.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Closing two gaps, head of Campbells Island	75	220.8			
Dam 3, wing, extended 350 feet	350	784.7			
Dam 6½, wing, repaired and paved	825	988	171.4	678.4	849.8
Dam 8, closing, repaired and paved	750	115.4	157.2	614.8	772
Dam 9, wing, finished and paved	535	3,126	101.1	452.8	553.9
Dam 10, wing, finished and paved	605	3,900.1	115.8	497.2	613
Dam 11, wing (new), finished and paved	1,650	8,599.3	318.3	1,304.1	1,622.4
Total		17,734.3	863.8	3,547.3	4,411.1

Cost of dams, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Cost per cubic yard.
Riprap stone in place	17,734.3	$18,514.61	$1.044
Paving stone in place	4,411.1	14,508.46	3.289
Total	22,145.4	33,023.07	.....

Average cost per cubic yard in place $1.491

Financial statement for improvement of Rock Island Rapids for season of 1893.

Amount expended in field	$54,970.34
Add quota of general superintendence and office expenses	1,407.20
Add for use and deterioration of plant	4,452.21
Total	60,829.75

Distributed as follows:

1. Rock excavated and removed	13,748.49
2. Rock broken up but not removed	5,242.03
3. New guide piers (Nos. 20, 21, and 24)	8,155.57
4. Repairs to old guide piers (Nos. 5, 7, 8, 9, 10, and 12)	660.59
5. Dams 3, 6½, 8, 9, 10, 11, and 2 gaps at head of Campbells Island	33,023.07
Total	60,829.75

BUOYS ON ROCK ISLAND RAPIDS.

The buoys, having been repaired and repainted, were reset April 8 to 13, 1893, with the exception of Nos. 17, 17½, and 25, which were reset later at a lower stage. All of the range stakes were carefully examined and repaired.

During the season many of the buoys were carried away by rafts, and these to the number of 8 were replaced. There are now 30 buoys in the system. On November 3, the range stakes having been again repaired, the buoys were taken up and stored for the winter. The cost of buoyage for the season of 1893 was $545.98.

SURVEYS.

A party in charge of Mr. E. E. Barrett was put in the field early in July, 1893. This party was engaged until November 12, and succeeded in making an excellent detailed hydrographic survey of the river and its side sloughs, etc., from a point about 3 miles below Clayton, to Savanna, a distance of 89 miles by river. The maps, now being plotted in the office at Rock Island, are nearly completed. A survey of the river in the vicinity of Moline was also made during the season. The cost of these surveys will aggregate about $5,000.

It is very desirable that the river from Savanna to Le Claire be surveyed at an early day, to facilitate the making of plans for improvement, as no survey of this part of the river has been made since 1878.

Very respectfully, your obedient servant,

J. C. McELHERNE,
Superintendent.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 29, 1894.

MAJOR: I have the honor to submit the following report of operations for work done under my direction between Keithsburg and Quincy, Ill., during the calendar year ending December 31, 1893.

KEITHSBURG TO MONTROSE.

This work was carried on under the local charge of Overseer John R. Carpenter, whose report is given below:

"The work was carried on by days' labor and use of Government plant, the *Vixen* being used as towboat. Actual work was begun July 20, 1893, in vicinity of Dallas City, in the construction of shore protection on Thompson Island, and continued in that locality until November 6. During this time 10,316 linear feet of bank were protected on Thompson Island (384); 1,200 linear feet on Burlington Island (377); 150 linear feet of shore protection were repaired at head of Polk Island (386), and 3,548 linear feet of dams were constructed.

"On November 6 the fleet was moved to vicinity of Montrose, at which point work was carried on until close of season, November 15. Three thousand one hundred linear feet of bank on main shore above Montrose were protected.

"The series of dams constructed in vicinity of Dallas City was built with the view of forcing the main draft of water through Dallas Chute and scouring out the bar which had begun to form opposite head of Polk Island. One dam (No. 7, sheet 60), connecting head of Polk Island with sand bar, was built; two dams (Nos. 5 and 6) were built out from sand bar, and Dam 9 was built, connecting the two small tow-heads just below brush and pile dam 4, constructed in 1892, in order to check the back current formed under this dam. This series of dams practically closes this side of the river at an average stage of water and forces the water through Dallas Chute.

"The past season was an exceptionally good one for work in this vicinity, although operations were slightly impeded by the low stage of water at times.

"On the morning of August 21 the *Vixen* broke her shaft at head of Twin Island, which necessitated her being taken into the canal for repairs, being towed in by the United States Steamer *Patrol*, and was laid up until August 27, during which time the *Lucia* was used as towboat.

"At the close of the season there remained on hand 492.8 cubic yards of rock, valued at $197.12."

List of works constructed and repaired, and of material used, during the season of 1893, between Keithsburg and Montrose.

Designation.	Dimensions.		Material.	
	Length.	Height above low, water, 1864.	Rock.	Brush.
Sheet 60:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 5	1,050	4	4,524.5	8,160.3
Dam 6	940	4	2,719.9	5,572.3
Dam 7	1,300	1	2,457.1	4,464.5
Dam 9	258	4	283.9	614.8
Shore protection, Island 377	1,200	.....	1,426.3	1,158.5
Shore protection, Island 384	10,316	.....	11,015.9	10,873.5
Shore protection, Island 386, repaired	.....	.....	208.7	.....
Sheet 62: Shore protection at Montrose	3,100	.....	3,223.7	3,073.5
Total materials put in works	.....	.....	25,860	33,916.4

Financial statement for works of improvement between Keithsburg and Montrose during season of 1893.

Amount expended in field during the calendar year 1893 (from distribution sheets)	$36,720.89
Deduct retained percentage of 1892	242.84
	36,478.05
Add cost of material on hand January 1, 1893	327.12
Add retained percentage of 1893	1,429.98
Total cost of field work	38,335.15
Deduct material on hand January 1, 1894	197.12
Net cost of field work	38,038.03
Add quota of general superintendence and office expenses	970.44
Add for use and deterioration of plant	2,351.35
Total cost	41,359.82

ıt in works:		
	cubic yards..	25,860.0
	do....	33,916.4
	do....	59,776.4
st per cubic yard—		
ges		$0.448
ving and putting in place		.188
ieral superintendence and office expenses		.016
ınt		.039
age cost per cubic yard in place		.691

DREDGING BELOW KEITHSBURG.

Phœnix, with launch *Lucia* as tender, began operations in removing sand ers from channel below Keithsburg on July 15, 1893, and continued work st 8, when the *Phœnix* was taken up river by the snag boat *General Barnard*. re removed 5,874 cubic yards material, chiefly sand, at a cost of $938.94.

KEOKUK TO QUINCY.

oject approved September 12, 1892, and allotment of $100,000, a contract, mber 7, 1892, was entered into with Thompson & Gray for construction ıd rock dams and shore protections, at $1.37 per cubic yard for rock in 17 cents per cubic yard for brush in place. The contract not being com- December 31, 1893, an extension of time to June 30, 1894, was granted. ın Layton was the inspector.

ns were begun on April 13, in vicinity of Warsaw and Alexandria, in the n of Dam 7 (sheet 63), and were continued there until August 12. During ,185 linear feet of dams and 1,040 linear feet of shore protection in the Warsaw, and 4,070 linear feet of shore protection in the vicinity of , were constructed; also, a break of 160 feet in Tully Island Dam (No. 3, n vicinity of Canton, was repaired.

st 12 operations were begun in the vicinity of Gregory Landing in the n of a series of dams running out from Illinois shore at Lower Bludsoes Three dams were constructed here, of a total length of 1,840 feet; 1,400 of bank at foot of Fox Island, and 7,570 feet on the main shore in the Gregory Landing, were protected. Operations were suspended Novem-

ovement at Warsaw and Alexandria consisted in the construction of a (No. 7, sheet 63) 1,200 feet long, located 1 mile above Alexandria; on the ide, completing the series of dams on that side above Alexandria; in 487 linear feet of Dam 5 and 498 feet of Dam 4, the same being brush, ravel dams constructed in 1892; in protecting 1,040 linear feet of shore of at the mouth of Des Moines River; in protecting 150 feet of levee above , and repairing 120 feet of old protection; in protecting 2,620 linear feet elow Alexandria making the protection complete on main shore from lexandria to head of Fox Island, and in raising 1,180 feet of old protection Fox Island from a 6-foot stage to top of bank. The improvement in this ives the river in good condition, having a complete bank protection and a series of wing dams from the Des Moines River to below Alexandria.

k at Gregory Landing was directed chiefly to the improvement of Lower rossing, which has for some years been a source of trouble to navigation eokuk and Quincy. The improvement consisted in the construction of dams, one (No. 4, sheet 64) 850 feet long, 1,200 feet below head of Hack- one (No. 6) 540 feet long, at head of Hackley Island, and one (No. 3) 450 rom main shore, 900 feet above head of Hackley Island. In addition to ıction of these dams, 1,400 feet of bank were protected at foot of Fox 20 feet above Gregory Landing in the intervening spaces of the old pro- d 5,650 feet below Gregory Landing, making about 2¼ miles of continuous ction. The bank in vicinity of Gregory Landing was 12 feet above low was riprapped to the top, brush being carried to the 6-foot stage, which le on all bank protection constructed. That portion of the work which ructed early in the season was carried on under some difficulties, on high water; but, as an offset, the large barges used by the contractors s stage carry full loads. As the water fell the work was greatly retarded, ıe clumsy and unwieldy nature of the plant used by the contractors.

List of works constructed and repaired and of materials used, during the season of 18 between Keokuk and Quincy.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Bru
Sheet 63:	*Feet.*	*Feet.*	*Cu. yds.*	Cu.
Dam 4, repaired	.....	5	711.4	
Dam 5, repaired	.....	5	1,154.4	
Dam 7	1,200	4.5	4,147.2	
Shore protection above Alexandria	270	12	192.6	.....
Shore protection below Alexandria	2,620	12	4,849.1	
Shore protection, Fox Island (head)	1,180	12	1,361.3	
Shore protection, Island 405	1,040	10	1,970.1	
Sheet 64:				
Dam 3	450	5	1,690.9	
Dam 4	850	5	3,729.5	
Dam 6	540	5	2,257.6	
Shore protection, Fox Island (foot)	1,400	10	2,039.9	
Shore protection above Gregory	1,920	12	3,665.4	
Shore protection below Gregory	5,650	12	9,683.2	
Sheet 65: Dam 3, repaired	.....	5	1,110	
Total	.....	.....	38,562.6	3

Financial statement for work between Keokuk and Quincy performed under contract ing season of 1893.

Amount paid contractors	$60,73
Add retained percentage on contract	6,74
Add cost of local inspection, etc	1,48
Add quota of general superintendence and office expenses	1,76
Add plant charges	31
Total	71,04
Material put in place:	
Rock ..... cubic yards	38,56
Brush ..... do	31,17
Total ..... do	69,73
Average cost per cubic yard in place	1.

IMPROVING QUINCY BAY.

Pile bulkhead.—Work on construction of a pile bulkhead at Whipple Creek, un contract with H. S. Brown, was commenced June 7, 1893. The bulkhead consist a row of piling spaced 4 feet apart, supporting a cap of 10 by 12 inch timber which is spiked sheet piling of 3 by 12 inch plank, the whole forming an inclos at the mouth of Whipple Creek for impounding the heavier deposits of that cr and keeping them out of the dredged channel.

Work was begun at a very favorable stage of water (12 feet above low wat with two pile-drivers and a dredge, the latter for furnishing the gravel filling, the water soon fell to a low stage and greatly impeded operations. Only a sm part of the gravel filling was put in as the work progressed, owing to shoal wa and lack of barges; enough was dumped about the bulkhead, however, to mak safe, and in October, when the ground had dried out, the contractor put on te and hauled gravel to all the places that seemed to need it, making a continuous b of about 6 feet wide on the inside and 12 to 18 inches deep.

During the summer months it was found that the sheet piling was exposed places, where the joints were not close, to the undermining of the small stream water flowing through the cracks whenever the creek was in freshet. To cor this, battens 1 inch thick by 4 inches wide were driven down on the inside of bulkhead, covering the open joint, and were spiked to the sheet piling. This, the gravel filling, is expected to entirely remedy the trouble. In one or two pla

where a small sink had occurred under the bulkhead, where the line crossed one of the old mouths of the stream, the contractor, at his own expense, hauled in brush and gravel and stopped the leak before any damage was done.

The contractor has on hand enough oak piling to finish the bulkhead (about 168 feet of which remains to be driven) and to fill out the various clusters and short spurs designed for the inside of the line of bulkhead, to break up scour alongside of it. It is proposed, when the work is resumed, to divert the course of the creek from its present mouth at the upper end of the bulkhead and make it discharge into the corner of the bay, away from the dredged channel. The gravel from the cut made for this purpose will be used for the inside and outside berms of the bulkhead.

The contractor secured an extension of his contract to June 30, 1894, by which time, with ordinary stage of water in the spring, he can easily complete it.

The following material remains to be put in place in the bulkhead:

2,240 linear feet oak piling, at $0.25	$560.00
2,754 feet, B. M., waling, at $0.0265	72.98
6,048 feet, B. M., sheet piling, at $0.0195	117.94
3,700 cubic yards gravel filling, at $0.30	1,110.00
Total	1,860.92

The above figures are somewhat under the original estimates, owing to part of the bulkhead (that extending out from shore) being shorter than contemplated. The water was so low that this part could not be driven, and the sawmill company ran out a pile of sawmill refuse to take its place, so that the connection with the shore is made—a large part of it—without expense to the United States.

Whatever money is left from this appropriation can best be expended in dredging a new outlet for the creek and strengthening the bulkhead with the dredged gravel. There will be a balance of about $1,300 for this purpose.

Both before and after the close of dredging operations, soundings were made outside of the bulkhead and a survey was made of the area inside of same, to record present conditions for future comparison.

Dredging.—Owing to the extensive deposit opposite the mouth of Whipple Creek and outside the line of the bulkhead, all low-water navigation between the upper and lower bay was shut off. The contraction of waterway caused by the bulkhead made it seem probable that by dredging a new channel parallel to the bulkhead and 60 to 80 feet wide, a permanent, or moderately permanent, channel between the upper and lower bay could be secured. Accordingly, an informal agreement, dated July 22, 1893, was made with Mr. H. S. Brown to dredge this channel—about 17,000 cubic yards of excavation being contemplated. Dredging was begun August 7, and continued to September 26. A good 4-foot channel was secured in front of the bulkhead, 80 to 100 feet wide and 1,200 feet long, and by far the best that has existed for a great many years, and affording means of relieving the lower bay of a great accumulation of log rafts, which threatened to blockade it. The dredging of this channel was a slow and laborious work, owing to the narrow channel and to the soft mud continually running in from the sides and getting dredge and towboat aground. On September 30 the canal launch *Lucia*, drawing about 2½ feet, passed through, the shoalest water being between the north end of the bulkhead and a point 200 feet up the bay, where the dredge had not yet worked.

The stage of water was 0.8 foot.

Eighteen thousand and sixty-one and three-tenths cubic yards of mud were removed, at a cost of 15 cents per cubic yard; total cost, $2,709.20. All of the dredged material was towed out into the river and dumped near the western shore, below the upper wing dam. The allotment for dredging mud ($2,500) was slightly exceeded, but the cost of work on the bulkhead will probably be considerably inside the limit of expense originally calculated, and all such surplus can be well expended in dredging, either to improve the channel or divert the creek toward the shore, as before stated.

A number of rafts were towed through the dredged channel, to and from the upper bay, late in September and early in October.

Mr. A. L. Richards, superintendent, was inspector on this work until June 10, at which date he was succeeded by Mr. W. E. Gordon, who served in the same capacity from June 11 to July 31; and from August 1 to October 30 Mr. C. E. Stewart acted as inspector.

Material statement.

Oak piling	linear feet..	12,451
Sheet piling	feet, B. M..	63,759
Waling	do....	24,207
Gravel filling	cubic yards..	725

Dredging.

Cubic yards material removed above the railroad bridge and dumped in Mississippi River	18,061.3

Financial statement.

Paid on contract on account of pile bulkhead	$4,699.95
Add retained percentage on contract	522.21
Lumber, day labor, etc., on pile bulkhead	104.12
Total	5,326.28
Dredging mud, 18,061.3 cubic yards, at 15 cents	2,709.20
Superintendence and office expenses	769.90
Total cost	8,805.38
Amount on hand, July 1, 1893	11,987.55
Amount available December 31, 1893	3,182.17

SURVEYS.

A survey of that portion of the channel below Keithsburg, obstructed by ledge rock and bowlders, was commenced August 17 and completed September 7. A good map has been made, on which a great many obstructions have been located. An examination was made September 11 and 12 of the Drews Prairie Crossing, but no rock above grade was found. Between September 13 and 23 a survey of the river in vicinity of Twin Islands was made. The map of this survey is now being plotted.

Very respectfully, your obedient servant,

M. MEIGS,
U. S. Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. S. EDWARDS, SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 24, 1894.

MAJOR: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge, for the calendar year ending December 31, 1893.

QUINCY BRIDGE TO CLARKSVILLE.

The work was carried on by days' labor and use of Government plant, the towboat *Coal Bluff* and launch *Stella* doing the towing. On April 9 the *Coal Bluff* and fleet left the Des Moines Rapids Canal for the vicinity of Hannibal, Mo.

Work during the season was carried on in the vicinity of Hannibal, Saverton, Hickory Chute, Louisiana, and Clarksville, Mo.

Vicinity of Hannibal.—Work was carried on from April 9 to 19, and from October 6 to November 15, 1893, and consisted in raising the shore protection on the Illinois shore, above the bridge, from 6 feet to 16 feet above low water for a length of 2,244 feet; in building 900 feet of protection on head of Turtle Island (No. 439); in building Closing dam 5 and Wing dam 6 (sheet 70). Closing dam 5 extends from head of Turtle Island in a northeasterly direction to the Illinois shore, closing the channel used by boats for a number of late years during low water. The length of the dam is 2,974 feet, of which 2,140 feet are built on a sand bar. That part of the dam which is located across the channel was built only to an elevation of 4.5 feet below low water of 1864, and should be raised to 4.5 feet above low water as early as possible. The object in building this dam was to throw the channel to the west of Turtle Island, and thereby straighten the channel, doing away with the present crooked and difficult approach to the bridge. Wing dam 6, 1,673 feet in length, was built 2,000 feet above the Closing dam, to further assist in bringing about good results. Of the latter dam, 840 feet were built on a dry bar.

Vicinity of Saverton.—A closing dam (No. 2, sheet 72), 840 feet long, was built from Island 415 to Illinois shore. This dam was built of piles, brush, and rock, similar in construction to the one built in 1892 near Dallas City, Ill. The closing of this chute no doubt improved the poor crossing at this point, but a number of wing dams should be built here to secure and make permanent a good channel, this being one of the worst places in this part of the river.

At Hickory Chute.—For a number of years the foot of Hickory Chute has been a great menace to navigation during low water, and at the lowest stages was practically impassable for the larger boats. Operations under the adopted plan for improving this point, which were commenced in 1892, were continued and completed in 1893, and consisted in building a dam 1,350 feet long, running downstream from foot of Island 455, with spurs extending toward the Missouri shore, and in building a number of wing dams from the Missouri shore east, narrowing the low-water channel down to 800 feet. Altogether, 7 dams were completed, one raised from low-water to a 5-foot stage, and one commenced but not completed. At no time since the work was fairly under way was there less than 4.5 of water, and even at a stage of 0.75 foot above low water of 1864, boats with heavy tows found plenty of water. As might be expected, on account of the scouring produced by the dams, the channel was crooked; but this will be changed as soon as the lower reef reaches Dam 6 (sheet 74). There still remains part of Dam 4 to be removed, and this should be done next spring by one of the dredges. The Illinois shore at foot of the chute was protected by revetment for a distance of 4,835 feet. The bank was from 10 to 16 feet above low water, and was cutting badly. The usual slope of 2 to 1 was observed.

Vicinity of Louisiana.—Dam 1 (sheet 75) was extended 897 feet, and built to 8 feet above low water; Closing dam 2 was raised; Wing dam 3 and shore protection in Buffalo Slough were repaired. Excepting Dam 2, the work was completed. Dam 2 was raised with brush and rock from 2 feet to 6 feet above low water, and piling driven 4 feet apart to a 14-foot elevation, but owing to the low stage of water no brush was put above the piling. This should be done next spring before or during high water, so that the deep slough below the dam, now 25 feet at low water, may fill up. The Illinois shore below Island 459 was protected for a length of 2,580 feet, and 800 linear feet of shore protection were built on Illinois shore between dams 3 and 4. The above two pieces of work were performed to prevent the destruction of the Sny-Island levee embankment, at a cost of about $4,000.

At Clarksville.—Dam 1 (sheet 76), opposite Clarksville, was repaired. The hole in this dam, which was 186 feet long and 25 feet deep at low water, was closed, and 148 feet additional of the dam were repaired.

In general.—Though the fleet was started out at a favorable stage of water for working, high water set in a few days later, and during April, May, and part of June, work was carried on under many difficulties. Much delay was caused by our inability to get brush in sufficient quantities. My experience in the spring of 1893 convinces me that certain kinds of work can be carried on advantageously during high water, providing brush can be cut during the previous winter and stored on high places.

In building dams during high water, nothing but wire should be used for making fascines into mats, and the dams should be left unfinished at 2 to 3 feet below grade. to be completed during a lower stage.

Much delay was caused by the accidents this season to the towboat *Coal Bluff*, which consisted in breaking her shaft July 24, and in striking an obstruction below Louisiana August 28 and sinking. The boat was raised and taken to Keokuk, Iowa, for repairs. During the absence of the *Coal Bluff* the towing was done by the United States launches *Stella* and *Lucia*, and by the private boats *Harry Reed* and *Innorator*.

Examinations of the river were made at Turtle Island and at Saverton, and the maps of same sent to the office at Rock Island, Ill.

I take pleasure in extending to Mr. Edward H. Jones, receiver of materials, my thanks for his faithful services during the season.

Prices paid for material on United States barges ranged from 53 to 62 cents per cubic yard for rock, and from 20 to 30 cents per cubic yard for brush.

List of works constructed and repaired, and of materials used, during the season of 1893, between Quincy bridge and Clarksville, including work performed to prevent the destruction of the Sny Island levee embankment.

Designation.	Dimensions.		Materials.		
	Length.	Height above low water, 1864.	Rock.	Brush.	Piling.
	Feet.	*Feet.*	*Cu. yds.*	*Cu. yds.*	*Lin. feet.*
Sheet 70:					
Wing dam 6	1,673	1.5	1,729.8	3,223	.....
Closing dam 5 commenced	2,974	.....	6,093.7	5,563	.....
Shore protection, Island 439	900	.....	803.1	356	.....
Shore protection, Illinois shore, raised and repaired	.....	.....	1,872.9	.....	.....
Sheet 72: Closing dam 2	840	6	1,513.6	2,320	5,058
Sheet 74:					
Trailing dam 5 raised	.....	5	1,325.7	2,953	.....
Wing dam 6	780	4.5	2,062.7	4,348	.....
Wing dam 7	1,020	5	2,826.5	3,239	.....
Wing dam 8	250	5	1,389	1,465	.....
Wing dam 9	250	4.5	881.4	1,525.4	.....
Wing dam 10	160	4.5	694.8	877	.....
Wing dam 11	90	4.5	355	488	.....
Wing dam 12	730	4.5	1,431.5	2,817	.....
Wing dam 13 commenced	1,000	.....	1,196.9	2,880	.....
Shore protection on Illinois shore	4,835	.....	5,379.2	5,179	.....
Sheet 75:					
Wing dam 1 extended	897	8	5,025.6	6,393	576
Closing dam 2 raised, but not completed	.....	6	404.3	666	2,180
Wing dam 3 repaired	1,140	4.5	2,116.4	1,428	.....
Shore protection in Buffalo Slough repaired	.....	.....	271.7	.....	.....
Shore protection between Dams 3 and 4 (Sny levee)	800	.....	1,284.8	494	.....
Sheet 76:					
Closing dam 1 repaired	.....	.....	1,505.6	2,561	.....
Shore protection near Island 459 (Sny levee)	.....	.....	2,007.6	2,176	.....
Total	.....	.....	42,171.8	50,951.4	7,814

Financial statement for work between Quincy bridge and Clarksville, including Sny Levee, performed by hired labor during season of 1893.

Amount expended in the field during the calendar year 1893, (from distribution sheets)	$65,002.57
Deduct retained percentage of 1892	273.88
	64,728.69
Add retained percentage 1893	411.36
Add quota of general superintendence and office expenses	1,667.58
Add for use and deterioration of plant	7,150.99
Total	73,958.62
Material put in works—	
Rock ..... cubic yards	42,171.8
Brush ..... do	50,951.4
Piling (7,814 linear feet) ..... do	289.4
Total	93,412.6
Average cost per cubic yard—	
On barges	$0.417
For towing and putting in place	.280
For general superintendence and office expenses	.018
For plant	.077
Average cost per cubic yard in place	.792

NOTE.—If the loss occasioned by the sinking and breaking of the shaft of the *Coal Bluff* be deducted, the cost per cubic yard in place will be reduced 3 cents.

QUINCY BRIDGE TO HANNIBAL.

Under project approved July 27, 1893, and allotment of $50,000, a contract dated ptember 7, 1893, was entered into with Patterson Bros., of Keokuk, Iowa, for the nstruction of dams and shore protections between Quincy bridge and Hannibal, $1.09 per cubic yard for rock, and $0.43 per cubic yard for brush in place.
Work was commenced October 12, 1893, and discontinued on account of cold ather November 16. It will be resumed in 1894. The work consisted in building 50 feet of shore protection on Orton Island (429). The bank being of a very ndy nature, brush was carried up about half way to the top. The average height the bank was 14 feet above low water of 1864, and the width of the protection, m top of bank to outer end of apron, was about 50 feet.
he intention was to start the Patterson Bros. at work improving Whitney Bar, ; owing to the low stage of the river, which made it impossible to do any work hout endangering navigation, it was postponed until 1894.
Ir. Edward A. Sisson was the inspector.

Work constructed between Quincy bridge and Hannibal during season of 1893.

Designation.	Dimensions (length).	Material.	
		Rock.	Brush.
t 68: shore protection on Orton Island	*Feet.* 2,650	*Cu. yds.* 5,626	*Cu. yds.* 3,076.8

ncial *statement for work between Quincy bridge and Hannibal performed under contract during season of 1893.*

ount paid contractor	$6,709.80
retained percentage	745.54
t of local inspection, etc	392.69
quota of general superintendence and office expenses	200.91
plant charge	13.69
Total	8,062.63

erial put in works—

Rock	cubic yards	5,626
Brush	do	3,076.8
Total		8,702.8
Average cost per cubic yard in place		$0.926

Very respectfully, your obedient servant,

S. EDWARDS,
Superintendent.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF LIEUT. W. V. JUDSON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., February 26, 1894.

MAJOR: I have the honor to report as follows on the works of which I was in local arge during the calendar year ending December 31, 1893.

CLARKSVILLE TO HAMBURG.

Under an allotment of $50,000, in accordance with project approved May 8, 1893, ontract dated August 7, 1893, was entered into with James Short for the conruction of rock and brush dams and shore protections. Under this contract work

was begun September 15, 1893, and closed for the season November 25, 1893. The prices paid for material in place were $1.35 per cubic yard for rock, and 49 cents per cubic yard for brush. Mr. I. Mathewson was the inspector in local charge.

The amount of work done by the contractor was insufficient, considering the time he worked. His plant was in bad repair, and his management was poor.

The character and extent of the work done are shown in my "outline sketches showing work accomplished," already transmitted to you, and in the following table:

List of works constructed and repaired, and of materials used, under contract with James Short, during the season of 1893, between Clarksville, Mo., and Hamburg, Ill.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 77—	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 3, closing McCoy's Chute, raised and repaired	1,200	6	4,520.4	2,421.1
Shore protection, head of Island 470	1,260	.....	4,745.9	2,607.9
Shore protection begun, head of Island 466	600	.....	2,065.2	2,324.2
Total	.....	.....	11,331.5	7,353.2

Financial statement for work between Clarksville, Mo., and Hamburg, Ill., performed under contract during the season of 1893.

Amount paid James Short, including $1,890.06 retained percentage December 31, 1893		$18,900.60
Cost of local inspection, etc		676.79
Add for superintendence and office expenses		475.57
Add for use and deterioration of plant		33.30
Total		20,086.26
Material put in works—		
Rock	cubic yards	11,331.5
Brush	do	7,353.2
Total	do	18,684.7
Average cost per cubic yard in place		$1.075

HAMBURG TO CAP AU GRIS.

Under an allotment of $75,000, in accordance with project approved by Chief of Engineers May 8, 1893, a contract dated August 8, 1893, was entered into with Jacob Richtman for construction of rock and brush dams and shore protections. Under this contract work was begun September 4, 1893, and was still in progress December 31, 1893. The prices paid for material in place were $1.25 per cubic yard for rock, and 50 cents per cubic yard for brush.

Mr. J. A. Macfie, Mr. I. Mathewson, and Mr. A. L. Richards, superintendent, served at different times as local inspectors.

As the season of low water approached, the vicinity of Westport Island became very difficult of navigation, so much water passing down behind the island through a considerable break in the closing dam across the chute. Accordingly this locality was chosen for the beginning of the work. The effect of repairing and raising this closing dam, and of building a wing dam above Kellys Island and opposite the head of Westport Island, was felt in a very short time, a channel being formed almost immediately through the flat bar that had been the original obstruction. The extent and character of this and the other work done by the contractor are shown in my "outline sketches of works accomplished," already transmitted to you, and in the following table:

List of works constructed and repaired, and of materials used, during the season of 1893, under contract with Jacob Richtman, between Hamburg, Ill., and Cap au Gris, Mo.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Brush.
Sheet 79:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 5, raised and repaired	.....	7	6,521.1	5,683.4
Wing dam 12, nearly completed	1,220	6	4,539.3	5,552.9
Closing dam 13, partly built	.....	.....	2,646.7	3,345.5
Closing dam 14, partly built	.....	.....	1,841.7	2,663.4
Shore protection on Reds Landing, extended	1,310	.....	3,314	2,883.9
Sheet 81:				
Closing dam 1, repaired	.....	.....	102.1	.....
Closing dam 2, repairs begun	.....	.....	531.2	915.7
Shore protection on Island 501, repaired and extended	.....	.....	1,350.6	1,624.8
Total	.....	.....	20,846.7	22,669.6

Financial statement for work between Hamburg, Ill., and Cap au Gris, Mo., performed under contract during the season of 1893.

Amount paid Jacob Richtman, including $9,334.70 retained percentage, December 31, 1893		$37,393.17
Cost of local inspection, etc		1,010.54
Add for general superintendence and office expenses		983.14
Add for use and deterioration of plant		47.35
Total		39,434.20
Material put in works:		
Rock	cubic yards	20,846.7
Brush	do	22,669.6
Total	do	43,516.3
Average cost per cubic yard in place		$0.906

CAP AU GRIS TO ILLINOIS RIVER.

Under an allotment of $60,000, in accordance with project approved by Chief of Engineers May 8, 1893, a contract, dated August 7, 1893, was entered into with James Short for the construction of dams and shore protections. The prices to be paid for material in place are $1.24 per cubic yard for rock and 44 cents per cubic yard for brush. During the calendar year no work was done under this contract.

ILLINOIS RIVER TO MISSOURI RIVER.

Under allotment of $95,000, in accordance with project approved May 8, 1893, work was carried on in this section by day labor and use of Government plant, the materials being secured by day labor, by purchase in open market, and by formal contract.

The method of improvement was the same as used in former years upon the Upper Mississippi River, consisting of spur dikes of rock and brush, to contract the channel, and the protection of caving banks with the same materials.

Operations were confined to the vicinity of Piasa Island. A dam had long existed between Piasa Island and the Missouri shore, located there originally in expectation of making a good channel at all stages down Piasa Chute. But the presence of rock in the upper part of the chute prevented a sufficient scour, and eventually a hole was made in the dam above mentioned, the low-water navigable channel being through this hole, and very tortuous and shoal above and below it, due to accumulations of sand induced by the dam. One thousand six hundred linear feet of this dam was dredged out. Piasa Chute was closed. Several wing dams were built below and above the site of the old dam, and a considerable amount of shore was protected. As far as possible the order of work was chosen with a view to giving immediate relief to navigation, and at no time during the low water were boats subject to the delays and difficulties of former years. There was evidence at the close of operations that a considerable improvement was being effected by the new works.

Before the channel in this vicinity can be considered permanent within the lines laid down on the present project map, there must be added an amount of work at least equal to that done this season.

The work of construction extended from July 5 to November 23. The steamer *J. G. Parke*, steam launch *Iris*, and proper barges, quarter boats, etc., all being Government plant, were employed during the season.

The dredge *Vulcan* was engaged from September 29 to November 18 in the removal of the old dam. The rock thus dredged was used in the new work.

The character and extent of the work done are shown in my "outline sketches showing work accomplished," already transmitted to you, and in the following tables:

List of works constructed and repaired, and of materials used, during the season of 1893, between Illinois River and Missouri River.

Designation.	Dimensions.		Material.		
	Length.	Height above low water 1864.	Rock.	Brush.	Piling.
Sheet 84:	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*	*Lin. ft.*
Dam 2, shore protection for, on Missouri side	.....	.....	344.3	1,509.7	.....
Dam 4	2,000	6	14,077	10,827.2	.....
Dam 5, shore protection for, begun	.....	.....	217.1	.....	.....
Dam 6	450	6	1,455	1,757.6	.....
Dam 7	857	7.5	5,667.7	6,443.3	2,430
Dam 8	1,020	7	6,888.5	5,020.5	800
Dam 9	700	6	3,396	6,609.7	.....
Dam 10	763	7	4,355.1	3,909.1	.....
Dam 11	190	6	440.4	2,313.3	.....
Dam 12	1,547	6	5,842.8	6,512.6	.....
Shore protection below Portage	3,100	.....	11,523.2	4,380.3	.....
Shore protection, Search Island	1,850	.....	3,238.4	1,465	.....
Total	.....	.....	57,445.5	50,838.3	3,230

Financial statement for work of constructing dams and revetments between Illinois River and Missouri River, performed by hired labor during the season of 1893.

Amount expended in field during the calendar year 1893		$63,220.70
Add retained percentage		861.05
		64,081.75
Deduct for material on hand at close of season	$449.50	
Deduct for pile-construction work (piles, linear feet, 3,230)	739.00	
		1,188.50
Net cost of field work		62,893.25
Add quota of general superintendence and office expenses		1,640.50
Add for use and deterioration of plant		5,978.83
Total		70,512.58
Material put in works:		
Rock	cubic yards	57,445.5
Brush	do	50,838.3
Total	do	108,283.8
Average cost per cubic yard—		
On barges		$0.337
For towing and putting in place		.244
For general superintendence and office expenses		.015
For plant		.055
Average cost per cubic yard in place		.651

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER, ON PLANT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 29, 1894.

)R: I have the honor to present the following report on the floating stock or elonging to the improvement of the Mississippi River between the mouth of ssouri River and Minneapolis for the calendar year ending December 31, 1893.

* * * * * *

is report "good" is in fine condition, wanting slight repairs or none; "fair" s extensive repairs or such as are advisable; "bad" should be condemned or . Pieces already condemned are omitted. The plant in question is as fol-One large towboat (*Coal Bluff*), good; 3 medium-size towboats (*Alert, Fury, xen*), good; 1 small towboat (*Freddie*), good; 5 steam launches (*Lucia, Emily, Elsie,* and *Iris*), good; 1 steam launch (*Louise*), fair; 1 small steam launch ice), fair; 3 small naphtha launches (*Myra, Dart,* and *Edith*), good; 2 dredges x and *Vulcan*), good; 3 dumps, good; 3 dumps, fair; 2 dumps, bad; 3 steam-oats, good; 2 pile-drivers, good; 2 pile-drivers, fair; 4 large quarter boats, small quarter boats, good; 2 small quarter boats, fair; 2 large office boats, 9 small office boats, good; 6 large model barges, fair; 44 large barges, good; barges, fair; 6 large barges, bad; 8 small barges, good; 1 small barge, small barges, bad, and a large number of skiffs, loading boats, powder boats, asshoppers in good condition.

ng the year, under projects approved August 9, 1892, May 8 and September 3, and special authorities of August 10, September 10, September 16, 1892, y 24, February 13, March 10, March 20, March 21, 1893, July 27 and August 3, considerable additions and repairs to plant were made. There were pur-10 barges (110 by 24), at $1,600 each; 7 barges (100 by 20), at $806 each; 1 (80 by 18), at $540; 1 towboat (*Freddie*), at $2,500; 1 launch (*Myra*, Daimler), at $992; 1 launch (*Dart*, naphtha), at $625.

e were built at Keokuk 1 steam-drill boat, at a cost of $4,705; 4 building at $1,385 each; 3 fuel flats, at $1,350 each; 1 pile-driver hull, at $1,400; 8 small boats, at $201 each; and several small pieces, such as magazine and powder grasshoppers, skiffs, etc. There were built at La Crosse 2 office boats and 1 r boat, at an aggregate cost of $1,624.

e were rebuilt 2 quarter boats and the hull of dredge *Vulcan*.

ensive repairs were made to towboats *Coal Bluff, Alert, Fury*, and *Vixen;* to es *Louise, Elsie, Ada*, and *Iris;* to dredge *Phœnix*, drill boat No. 103, 1 pile-, and 2 barges. Nominal repairs were made to launches *Florence, Lucia,* and *Edith;* to 1 drill boat, 1 office boat, 1 pile-driver, 11 quarter boats, and ges.

ar the greater part of the construction and repair work was done at the Des s Rapids Canal and Dry Dock, under supervision of Mr. M. Meigs, U. S. civil er.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 2, 1894.

OR: I have the honor to present a brief preliminary report of operations en Missouri River and Minneapolis during the second half of the fiscal year June 30, 1894, as collated from reports of assistants in local charge. Full s are made by calendar years.

eapolis to St. Paul.—In local charge of Supt. J. D. DuShane. A report on the of 1893, made with the view of preparing exact estimates of cost of locks and was rendered March 1, 1894. Records of several gauges were kept in May and No field work has been done in 1894.

aul to Lake Pepin.—In local charge of Supt. J. D. DuShane. No construction as been done in 1894. Some repairs to plant have been made.

s Bar to Lake Pepin.—In local charge of Supt. J. D. DuShane. Work in pro-of cutting banks, under contract with Jacob Richtman, was resumed June 1, and carried on to end of fiscal year. Two thousand linear feet of west bank

below outlet of Sturgeon Lake were protected, 3,100 cubic yards of rock and 2,823 cubic yards of brush being put in place.

Minneiska to Genoa.—In local charge of Supt. W. A. Thompson. Repairs were made to the plant used in this section of the river. Operations were resumed in vicinity of Chimney Rock June 25, 1894, and carried on with a small force to end of fiscal year.

Genoa to Prairie du Chien.—In local charge of Supt. W. A. Thompson. Work in construction of dams and shore protections, under contract with Bigelow & Teasdale, was resumed April 2, 1894, and carried on to May 1, on which date the contract was completed. Dams, with necessary shore protections, were built, closing Iowa, McDonalds, and Caya sloughs.

Amounts of materials put in: Rock, 5,496.9 cubic yards; brush, 8,255.7 cubic yards.

Dubuque to Clinton.—In local charge of Supt. J. C. McElherne. Work in construction of dams and shore protections, under contract with Bigelow & Teasdale, was commenced May 3, 1894, and carried on to end of fiscal year. A dam-closing chute of Island 264, near Savanna, was built, and a wing dam running out from Island 266 was commenced. Extensive repairs were made to closing dam opposite Bellevue, and the same was raised and widened to permit of its being used as a wagon road.

Amounts of materials put in: Rock, 9,419.4 cubic yards; brush, 15,692.5 cubic yards.

Rock Island Rapids.—In local charge of Supt. J. C. McElherne. The plant used on the rapids was put in good repair during the spring. On March 27, 1894, drill boat No. 103, with double crew, was put at work at Winnebago Chain, and remained there until June 7, when she was moved to Upper Chain, where she continued operations in removing rock from channel until the close of the fiscal year Two thousand six hundred and thirty-seven solid cubic yards of rock were broken up, and the débris will be removed by dredge later in the season.

Buoys on Rock Island Rapids.—The buoys, having been repaired and repainted, were reset June 17 to 21, 1894. There are now 28 buoys in the system, 27 of which were replaced. All range stakes were carefully examined and repaired.

Keithsburg to Montrose.—In local charge of Mr. M. Meigs, U. S. civil engineer. The plant used in this section of river has been put in good repair, but no work has been done in the field except the breaking up of some patches of rock near Montrose by drill boat No. 6.

Keokuk to Quincy.—In local charge of Mr. M. Meigs, U. S. civil engineer. Work in construction of dams and shore protections, under contract with Thompson & Gray, was resumed March 23, 1894, and continued until completion of contract, June 7. Three thousand three hundred and twenty-five linear feet of shore protection were built on west bank below Gregorys Landing, and 1,280 feet on east bank above the lower Bludsoe Crossing. A wing dam above the tow-head was also constructed.

There were put in the above-mentioned work 12,871.9 cubic yards rock and 8,721 cubic yards brush. Considerable work in raising and strengthening the closing dams at Canton and Smoat chutes was performed in May and June, partly under agreement with H. S. Brown and partly by days' labor.

Improving Quincy Bay.—In local charge of Mr. M. Meigs, U. S. civil engineer. The pile bulkhead at Whipple Creek, commenced under contract with H. S. Brown, June 7, 1893, was completed June 27, 1894. There were put in place in 1894, 3,370 linear feet oak piling, 3,174 feet (B. M.), sheet piling, 2,750 feet (B. M.), waling, and 4,771 cubic yards gravel filling. Under agreement with Mr. Brown, 2,888 cubic yards of material were dredged and removed from the channel of the bay.

Quincy Bridge to Hannibal.—In local charge of Superintendent S. Edwards. Constructions of dams and shore protections, under contract with Patterson Bros., was resumed April 23, 1894, and carried on to close of fiscal year. A closing dam at Fabius Island was constructed and a similar dam at Glaucus Island commenced. Four wing dams, aggregating 2,600 feet in length, were built from Missouri shore above Glaucus Island, and one wing dam from Missouri shore above Ortons Island. Some repairs were made to shore protection at Turtle Island.

There were put in the work 18,964 cubic yards rock and 15,717 cubic yards brush.

Quincy to Clarksville.—In local charge of Superintendent S. Edwards. No work has been done in the field. Some repairs to plant used in this section of the river have been made.

Clarksville to Hamburg.—In local charge of First Lieut. William V. Judson, Corps of Engineers. Construction of dams and shore protections, under contract with James Short, was resumed March 24, 1894, and continued until May 26. A closing dam at Amaranth Island Chute was built, and the Clarksville Island dam was repaired.

Amounts of material used: Rock, 9,186.6 cubic yards; brush, 7,779.2 cubic yards.

Hamburg to Cap au Gris.—In local charge of First Lieut. William V. Judson, Corps of Engineers. Construction of dams and shore protections, under contract with Jacob Richtman, was continued from January 1, 1894, to May 5, at which latter date

the contract was completed. Repairs were made to the dams closing Westport Chute; one wing dam and two closing dams were completed; 21,474.1 cubic yards rock and 18,323.4 cubic yards brush were put in the work.

By days' labor two pile dams were placed in Westport Chute to diminish the pressure on the main closing dam.

Cap au Gris to mouth of Illinois River.—In local charge of First Lieut. William V. Judson, Corps of Engineers. Construction of dams and shore protections was in progress under contract with James Short from April 19 to close of fiscal year. A closing dam was built at Masons Chute; one closing dam was repaired and two commenced. A system of dams at foot of Sarah Ann Island was begun.

There were put in 14,397 cubic yards rock and 12,966 cubic yards brush.

Illinois River to Missouri River.—In local charge of First Lieut. William V. Judson, Corps of Engineers. No field work was performed. Extensive repairs to the plant used in this section of river were made.

Surveys.—A continuous detailed survey of the river from Savanna to Le Claire, 45 miles, was made, and the maps of the same have been plotted.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT ON IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN ST. PAUL AND MINNEAPOLIS, MINN.

[Printed in Senate Ex. Doc. No. 109, Fifty-third Congress, second session.]

WAR DEPARTMENT,
Washington, D. C., June 4, 1894.

SIR: In response to a resolution of the Senate, dated May 31, 1894, which was concurred in by the House of Representatives on June 1, 1894, directing—

That the Secretary of War be, and is hereby, authorized and directed to transmit to the Senate the reports of any surveys or estimates that may have been made since his last annual report to Congress with reference to the construction of locks and dams in the Mississippi River between the Chicago, St. Paul, Minneapolis and Omaha Railway bridge at the city of St. Paul and the Falls of St. Anthony, in the State of Minnesota—

I have the honor to inclose a letter from the Chief of Engineers, dated the 4th instant, submitting a copy of a letter of March 1, 1894, from Maj. Alexander Mackenzie, Corps of Engineers, presenting an estimate amounting to $2,205,159 as the cost of construction of 4 locks and 3 dams to extend navigation to the flour mills at Minneapolis.

Very respectfully,

DANIEL S. LAMONT,
Secretary of War.

The PRESIDENT OF THE U. S. SENATE.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 4, 1894.

SIR: I have the honor to acknowledge receipt of concurrent resolution which passed the Senate May 31 and the House of Representatives June 1, 1894, authorizing and directing the Secretary of War "to transmit to the Senate the reports of any surveys or estimates that

may have been made since his last annual report to Congress with reference to the construction of locks and dams in the Mississippi River between the Chicago, St. Paul, Minneapolis and Omaha Railroad bridge at the city of St. Paul and the Falls of St. Anthony, in the State of Minnesota," and in answer to its reference to this office for report, I submit the accompanying copy of letter of March 1, 1894, from Maj. Alexander Mackenzie, Corps of Engineers, in which an estimate is presented amounting to $2,205,159 as the cost of construction of 4 locks and 3 dams, to extend navigation to the flour mills at Minneapolis.

The concurrent resolution is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., March 1, 1894.

GENERAL: By letter dated Office Chief of Engineers, U. S. Army, February 15, 1893, I was instructed to prepare new and exact estimates for locks and dams, in connection with the improvement of the Mississippi River between St. Paul and Minneapolis.

Detailed surveys, including borings, were made during the low water season of 1893.

Plans for the locks and dams considered necessary have been prepared in sufficient detail to admit of the making of detailed estimates of cost.

The head of navigation on the Mississippi River has heretofore been considered by the appropriation acts of Congress as being at the old steamboat landing below the Washington avenue bridge, Minneapolis. To provide navigation to this point two locks and dams will be required. Lock and Dam No. 1 is placed just above Minnehaha Creek, with a lift of 13.3 feet. Lock and Dam No. 2 is placed about 1,000 feet below the Chicago, Milwaukee and St. Paul Railway bridge, below Meekers Island, with a lift of 13.8 feet.

To provide navigation to the proposed power dam of the Minneapolis Mill Company, about 3,000 feet below the Falls of St. Anthony, will require a third lock and dam, placed at the head of the rapids, about one-half mile below the steamboat landing, with a lift of 10.1 feet, and to extend navigation to the flour mills at Minneapolis will require Lock No. 4, at the site of the above-mentioned proposed power dam. While Lock No. 4 would extend navigation 3,000 feet there would be no space for maneuvering boats above the lock except such as would be afforded by a canal (the tail-race of the mills) 100 feet wide. Should navigation be extended above the Washington avenue bridge, two bridges must be remodeled and a third bridge changed to a drawbridge if a further extension to the tail-race of the mills is provided for.

The locks proposed have a chamber 80 feet wide and 334 feet long (being of same dimensions as the lock of the Des Moines Rapids Canal), with 5 feet on the lower miter sill at low water. They are to be constructed of best class of masonry, according to most approved designs. The dams proposed are crib work, filled with riprap rock and gravel, backed with gravel.

The following is a summarized estimate of the cost of Lock and Dam No. 1:

Lock	$396,443
Abutment	29,598
Dam	68,697
Landing piers	11,131
Guide piers	10,697
	516,566
Add 10 per cent for land, engineering, and contingencies	51,656
Total estimate	568,222

Summarized estimate of the cost of Lock and Dam No. 2.

Lock	$427,182
Abutment	29,598
Dam	62,033
Landing piers	11,131
Guide piers	13,906
	543,850
Add 10 per cent for land, engineering, and contingencies	54,385
Total estimate	598,235

Estimated cost of extending navigation from St. Paul to the Washington avenue bridge at Minneapolis by two locks and dams (Nos. 1 and 2).

Lock and Dam No. 1	$568,222
Lock and Dam No. 2	598,235
Total	1,166,457

To extend navigation to the flour mills at Minneapolis requires locks and dams (Nos. 3 and 4):

Estimated cost to Washington avenue bridge	$1,166,457
Lock and Dam No. 3	538,702
Lock No. 4	500,000
Total	2,205,159

The construction of Lock and Dam No. 2 would in itself be of some benefit to interests of navigation, as the river can be navigated to the site of such dam at some stages when the upper portion is unnavigable; but to secure practical navigation at all times to the Washington avenue bridge the construction of Nos. 1 and 2 is necessary.

In addition to the lock and dam construction, an expenditure of, approximately, $60,000 would probably be required for additional dredging work below Minnehaha Creek.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Y 3.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

There was available for this work July 1, 1893, the sum of $2,681.45. During the year two patches of rock in the channel, about 1 mile above the guard lock, were drilled and blasted, and one guide pier was

built on the outside of the channel, about midway between Mechanics Rock and the foot of the cut at Nashville. In the accomplishment of the above-mentioned work the available funds were exhausted. No further appropriation is required for the completion of this improvement in accordance with approved project.

Abstract of appropriations.

By act approved—		By act approved—	
June 23, 1866	$200,000	June 18, 1878 (allotment)	$62,500
March 2, 1867	500,000	March 3, 1879	25,000
July 25, 1868 (allotment)	300,000	June 14, 1880	20,000
April 10, 1869 (allotment)	178,200	March 3, 1881	25,000
December 23, 1869	200,000	By act—	
July 7, 1870	400,000	Passed August 2, 1882	30,000
January 18, 1871	341,000	Approved July 5, 1884	50,000
March 3, 1871	250,000	Approved August 5, 1886	26,250
June 10, 1872	400,000	Of August 11, 1888	35,000
March 3, 1873	400,000	Of September 19, 1890	22,000
June 23, 1874	400,000		
March 3, 1875	480,000	Total	4,574,950
August 14, 1876	230,000		

Money statement.

July 1, 1893, balance unexpended	$2,681.45
June 30, 1894, amount expended during fiscal year	2,681.45

Y 4.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open for navigation 238 days, during which time there passed through it 619 steamboats and 312 barges, carrying 14,752 passengers, 43,182 tons of merchandise, and 83,650 bushels of grain. There also passed through the canal 117,360,783 feet, B. M., of lumber, 8,612,000 feet of logs, 54,710,727 shingles, and 42,112,415 laths.

The expenses of operating and caring for the "Des Moines Rapids Canal and Dry Dock," including dredging and extraordinary repairs to gates, machinery, and plant, during the past year have been $56,899.05. These expenses are provided for by an indefinite appropriation made by act of March 3, 1881.

During the year the lower lock gates were substantially repaired, and those of the middle lock were rebuilt. One of the upper gates of the middle lock was accidentally wrecked and had to be rebuilt, the same necessitating the closing of the canal for about two weeks. Dredge *Ajax* and two dumps, A and C, were almost entirely rebuilt. The booms at upper and lower ends of canal were maintained, and some light repairs were made to them. The two lower cribs above the guard lock were rebuilt. At the machine shop at lower lock a great amount of work was performed in building and repairing machinery of locks, launches, towboats, and dredges belonging to the United States. A comparatively small amount of dredging was done, the canal being in better condition than formerly, owing to the large quantities of material removed in the two previous years.

The dry dock was in constant use, and at times when not required for repairs to portions of the Government plant boats and barges

belonging to private parties have been docked and repaired. The dockage fees collected from private parties during the fiscal year amounted to $118.75.

Abstract of appropriations.

By act approved—	
April 30, 1878	$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, for fiscal year ending—	
June 30, 1882	45,000.00
June 30, 1883	75,000.00
June 30, 1884	47,000.00
June 30, 1885	40,500.00
June 30, 1886	43,000.00
June 30, 1887	44,000.00
June 30, 1888	42,000.00
June 30, 1889	39,000.00
June 30, 1890	43,837.97
June 30, 1891	43,995.80
June 30, 1892	44,000.00
June 30, 1893	58,000.00
June 30, 1894	56,652.49
Total	731,986.26

Money statement.

July 1, 1893, balance on hand		$975.67
June 30, 1894, amount drawn from Treasury under indefinite appropriation	$53,000.00	
June 30, 1894, amount called for but not received	3,652.49	
		56,652.49
		57,628.16
June 30, 1894, amount expended during fiscal year		55,356.48
June 30, 1894, balance on hand		2,271.68
July 1, 1894, outstanding liabilities		3,170.73

List of vessels docked at the dry dock at the Des Moines Rapids Canal during the fiscal year ending June 30, 1894.

Designation.	Date of entering dock.	Date of leaving dock.	Designation.	Date of entering dock.	Date of leaving dock.
	1893.	1893.		1893.	1893.
Dredge Vulcan	July 1	July 7	6 pontoons*		Oct. 16
Pile-driver No. 58	July 7	July 11	2 pontoons	Oct. 16	Oct. 24
Flat No. 50	July 11	Aug. 18	Pipe boat No. 2	Oct. 24	Oct. 26
Flat No. 44	July 19	July 22	Suction dredge 14	Oct. 24	Oct. 26
Flat No. 93	July 19	July 22	Pile-driver 33	Oct. 16	Oct. 24
Flat No. 79	July 22	July 25	Steamer General Barnard	Oct. 28	Nov. 8
U. S. steamer Lily	July 25	July 25	Launch Freddie	Nov. 8	Nov. 15
Drill boat No. 6*		Aug. 8	Dredge Ajax	Nov. 15	(‡)
Pile-driver No. 33*		Aug. 8	Flat No. 52	Nov. 15	Nov. 18
Flat H	Aug. 12	Aug. 18	Pile-driver 58	Nov. 15	Nov. 18
Steamer Mary Morton†	Aug. 18	Aug. 21	Dump boats A and C	Nov. 19	(‡)
Coal Bluff	Sept. 9	Sept. 17			1894.
Building boat 26*		Sept. 12	Barges 60, 61, 87, and 89	Nov. 19	Mar. 29
Building boat 31*		Sept. 21	Launch Stella	Nov. 19	Mar. 24
Building boat 36*		Sept. 28	Launch Edith	Nov. 19	Mar. 24
Coal flat 52	Sept. 28	Oct. 3			1893.
Coal flat 54	Sept. 29	Nov. 15	Lower Lock Bulkhead*		Nov. 18
Dump boat No. 2	Oct. 3	Oct. 24			1894.
Dump boat No. 6	Oct. 3	Oct. 26	Quarter boat No. 11*		Mar. 30
Building boat 38*		Oct. 7		1894.	
Pipe boat No. 5		Oct. 24	Barges Nos. 62 and 68	Mar. 29	May 23

* Built in dock. † Belongs to private parties. ‡ Still in dock.

List of vessels docked at the dry dock at the Des Moines Rapids Canal, etc.—Continued.

Designation.	Date of entering dock.	Date of leaving dock.	Designation.	Date of entering dock.	Date of leaving dock.
	1894.	1894.		1894.	1894.
Pile-driver No. 104	Mar. 29	Apr. 3	Quarter boat No. 71‡		Apr. 27
Dump boat B	Mar. 29	Apr. 3	Coal flat I	June 5	June 8
Dump boat D	Mar. 29	Apr. 3	Flat F	June 5	June 8
Dump boat 4	May 19	May 23	Steamer J. G. Parke	June 8	June 13
Flat No. 26	May 19	(*)	Flat No. 44	June 12	June 15
Lower Lock Bulkhead	May 19	(*)	Flat No. 116	June 12	June 15
Steamer Gem City†	May 23	May 25	Coal flat K	June 12	June 15
Dump boat No. 4	May 25	May 31	Dump boat No. 5	June 15	(§)
U. S. steamer Patrol	May 25	June 8	Dump boat No. 6	June 15	(§)
Dump boat No. 2	May 31	June 5	Flat No. 43	June 15	(§)
Survey boat Illinois	May 31	June 5	Lighter No. 99	June 15	(§)
Barge Caffrey	May 31	June 5	Flat No. 79	June 15	(§)
Launch Louise‡		May 31			

* Wrecked. † Belongs to private parties. ‡ Built in dock. § Still in dock.

Table showing the amount of material removed from the Des Moines Rapids Canal from June 30, 1878, to June 30, 1894.

Fiscal year.	Removed by United States dredges.	Removed by teams.	Removed by contract.	Total.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
1879	8,700			8,700
1880	26,496	1,228	11,553	39,277
1881	9,003			9,003
1882	18,031		49,758	67,789
1883	22,717		90,858	113,575
1884	52,616			52,616
1885	38,097			38,097
1886	65,970			65,970
1887	78,537			78,537
1888	47,333			47,333
1889	86,278			86,278
1890	23,830			23,830
1891	46,751			46,751
1892	149,618			149,618
1893	113,954			113,954
1894	58,025			58,025
Grand total				999,353

In addition to the above there have been removed from the head of the channel at Montrose, during the fiscal years ending June 30, 1883, 1884, and 1885, 16,643, 25,315, and 6,007 cubic yards of material, respectively; total, 47,965.

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1894.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1893.								
July	$375.00	$11.55	$2.37	$388.92	$1,775.00	$255.27	$320.52	$2,350.79
August	375.00	16.25	37.85	429.10	1,775.00	78.60	346.28	2,199.88
September	420.00	12.15	120.30	552.45	1,703.00	170.62	883.90	2,757.52
October	420.00	8.65	74.88	503.53	1,730.00	180.97	634.39	2,545.36
November	420.00	4.00	46.08	470.08	1,734.00	101.15	2,286.24	4,121.39
December	500.00	1.25	61.50	562.75	1,303.33	9.10	2,805.21	4,117.64
1894.								
January	500.00	9.50	31.64	541.14	1,391.00	4.40	1,562.73	2,798.13
February	500.00	5.40	43.72	549.12	1,305.00		2,071.74	3,376.74
March	500.00	1.25	126.20	627.45	1,488.32		454.97	1,943.29
April	375.00	31.70	50.67	457.37	1,821.00	303.85	1,521.77	3,646.62
May	375.00		66.80	441.80	1,841.00	138.33	107.00	2,086.33
June	375.00	20.01	49.55	444.56	1,819.00	564.75	40.10	2,423.85
Total	5,135.00	121.71	711.56	5,968.27	19,585.65	1,797.04	12,974.85	34,207.54

penditures for operating and care of Des Moines Rapids Canal, etc.—Continued.

Month.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1893.					
	$626.50	$213.79	$201.33	$1,041.62	$3,781.33
ist			8.86	8.86	2,637.84
mber					3,309.97
er					3,048.89
mber	59.16	55.37	56.74	171.27	4,762.74
ber			1,069.97	1,069.97	5,750.36
1894.					
ry			168.43	168.43	3,507.70
ary			1,357.84	1,357.84	5,283.70	
	256.00	16.15	408.44	680.59	3,251.33
	1,458.00	535.56	1,515.12	3,508.68	7,512.67
	1,550.00	671 99	2,604.24	4,826.23	7,354.36
	2,770.15	734.55	325.05	3,829.75	6,698.16
Total	6,719.81	2,227.41	7,716.02	16,663.24	56,899.05

rative expenditures for operating and care of Des Moines Rapids Canal for the fiscal years 1882–1894.

ear.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
	$3,710.00	$161.69	$550.62	$4,422.31	$21,122.70	$1,654.06	$1,946.03	$24,722.79
	4,821.12	289.86	449.52	5,560.50	25,813.40	2,216.87	3,203.01	31,233.28
	5,045.22	209.12	665.62	5,519.96	17,654.23	4,344.51	1,291.20	23,289.94
	5,015.00	245.31	573.88	5,834.19	17,615.97	1,995.92	5,237.88	24,849.77
	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,652.87	25,610.86
	4,375.00	85.19	424.48	4,884.67	18,326.23	2,752.80	3,775.59	24,854.62
	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	7,972.29	26,803.05
	3,750.00	26.80	318.82	4,095.62	17,241.79	2,277.97	3,689.20	23,208.96
	4,425.00	120.84	238.03	4,783.87	18,245.07	2,376.55	7,848.88	28,470.50
	5,175.00	162.76	113.38	5,451.14	18,785.73	2,725.27	11,863.31	33,374.31
	4,495.00	156.04	210.75	4,861.79	18,099.98	1,612.98	5,012.20	24,725.16
	5,720.00	137.13	138.73	5,995.86	17,464.67	2,162.64	6,822.35	26,449.66
	5,135.00	121.71	711.56	5,968.27	19,585.65	1,707.04	12,974.85	34,267.54

ear.	Dredging canal.					Miscellaneous.	Grand total.
	Labor.	Supplies.	Repairs.	Contract.	Total.		
	$2,340.43	$572.09	$846.58	$14,080.39	$17,839.49	$68.75	$47,053.34
	4,765.93	1,538.80	598.04	30,666.17	37,568.94	3,504.07	77,926.79
	7,485.45	4,789.32	1,262.02		13,536.79	536.73	43,283.42
	3,353.12	8,580.69	1,888.73		13,822.54		44,506.50
	4,984.55	3,017.49	3,530.41		11,532.45		43,009.53
	6,149.45	3,810.12	2,453.98		12,413.55		42,152.84
	5,084.77	2,267.62	1,808.85		9,161.24	1,327.32	42,802.35
	5,573.56	3,528.06	2,479.17		11,580.79		38,885.37
	3,196.58	1,260.78	6,284.07		10,741.43		43,995.80
	3,563.51	1,906.63	702.61		6,172.75		44,998.20
	11,333.23	6,370.52	4,259.47		21,963.22		51,550.17
	8,712.77	4,481.53	5,464.30		18,658.60		51,104.12
	6,719.81	2,227.41	7,716.02		16,663.24		56,899.05

Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1894.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Shingles.	Lath.	Lockages at one lock.
1893.					*Tons.*	*Bush.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	81	55	34	4,200	7,772	9,885	24,135,647	.....	9,290,422	10,998,210	241
August	47	47	40	3,574	2,908	7,500	27,374,885	3,862,000	14,718,100	8,779,050	218
September	24	31	31	177	927	1,905	30,313,831	2,750,000	12,107,025	10,129,650	229
October	25	23	36	.....	1,200	.....	25,825,760	.....	15,491,680	8,719,855	157
November	9	4	19	.....	120	.....	1,290,000	.....	.....	290,000	32
1894.											
March	7	5	15	.....	5,085	.....	.....	.....	.....	.....	18
April	36	19	47	59	11,545	.....	1,427,660	1,000,000	578,500	1,375,650	222
May	77	21	53	1,067	10,027	42,570	2,083,000	1,000,000	2,225,000	1,020,000	138
June	72	36	37	5,675	3,598	21,790	4,910,000	.....	300,000	800,000	139
Total	378	241	312	14,752	43,182	83,650	117,360,783	8,612,000	54,710,727	42,112,415	1,394

Comparative traffic statement showing the total traffic that has passed through the canal since its opening in 1877, by fiscal years ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Lath.	Shingles.	Lockages at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
1878	670	548	.....	53,346	737,415	25,000,000	.....	4,000,000	3,700,000	824
1879	802	454	5,088	64,658	2,192,642	33,347,612	8,086,000	8,721,796	11,749,000	1,564
1880	967	651	13,231	78,989	2,197,469	21,832,478	13,160,960	27,863,640	30,651,000	2,497
1881	840	276	10,003	44,962	1,154,092	52,256,235	11,013,410	11,657,655	15,091,000	1,339
1882	760	444	8,588	29,043	781,817	17,150,011	4,475,000	3,112,825	4,885,250	2,222
1883	1,107	705	9,192	43,359	729,174	13,093,325	1,040,000	11,558,000	4,435,000	1,353
1884	913	245	13,057	54,215	470,580	57,018,151	9,399,764	15,924,645	25,182,250	1,988
1885	889	169	13,065	54,120	776,432	43,119,797	2,779,670	13,473,205	25,018,750	1,270
1886	784	218	22,221	56,001	465,681	22,769,823	3,195,360	4,302,800	8,253,000	755
1887	990	818	20,797	52,815	366,432	178,754,876	24,827,000	19,961,781	90,450,922	1,717
1888	595	235	8,330	33,160	143,037	166,827,752	34,505,000	83,642,450	49,848,840	1,749
1889	1,022	288	22,880	50,008	381,559	118,508,045	26,333,320	50,221,099	37,413,810	1,941
1890	924	477	14,529	71,453	397,788	146,078,329	26,689,300	44,316,167	73,540,370	1,827
1891	378	357	15,801	45,217	364,878	193,358,089	37,176,150	59,350,595	87,259,690	1,885
1892	577	191	10,260	12,228	63,210	140,654,084	24,514,000	39,476,926	61,141,137	1,233
1893	670	234	10,846	33,318	53,257	80,190,519	16,350,200	29,121,020	28,896,260	1,476
1894	619	312	14,752	43,182	83,650	117,360,783	8,612,000	54,710,727	42,112,415	1,394

Dates of opening and closing of canal for all years since its opening to navigation.

Year.	Canal opened.	Canal closed.	River opened.	River closed.	Highest water.		Lowest water.	
						Feet.		*Feet.*
1877	Aug. 22	Dec. 10	Feb. 17	Dec. 12	Feb. —	20.55	Sept. —	0.65
1878	Mar. 8	Nov. 28	Open....	Dec. 20	June 11	12.05	Sept. 22	1.45
1879	Mar. 17	Dec. 9	Mar. 6	Dec. 26	June 2	8.45	Oct. 4	1.00
1880	Mar. 8	Nov. 19	Jan. 5	Dec. 8	June 29	17.50	Aug. 24	2.05
1881	Apr. 16	Oct. 17	Mar. 25	No close.	Oct. 29	18.95	Aug. 29	2.75
1882	May 6	Nov. 25	Open....	Dec. 15	Apr. 25	15.90	Oct. 5	2.05
1883	Apr. 13	Dec. 6	Mar. 1	Dec. 27	May 8	15.45	Sept. 22	2.10
1884	Apr. 1	Nov. 23	Mar. 15	Dec. 30	Mar. 31	16.80	Aug. 25	2.80
1885	Apr. 1	Nov. 24	Mar. 14	Dec. 14	Mar. 15	12.80	Nov. 30	3.40
1886	Apr. 1	Nov. 21	Mar. 15	Dec. 2	May 6	15.95	Dec. 1	0.50
1887	Mar. 28	Nov. 23	Feb. 11	Dec. 21	Feb. 12	11.60	Nov. 28	0.00
1888	Mar. 29	Nov. 22	Mar. 1	No close	May 16	19.65	Dec. 26	−0.80
1889	Mar. 18	Nov. 23	Mar. 3	Feb. 24	Feb. 26	10.75	Dec. 5	−0.70
1890	Apr. 1	Nov. 20	Jan. 28	Jan. 21	June 30	12.60	Jan. 8	−2.40
1891	Apr. 1	Nov. 21	Open....	No close.	Mar. 29	10.80	Nov. 30	−1.60
1892	Apr. 1	Nov. 23	Feb. 2	Dec. 23	June 30	19.25	Dec. 18	−0.80
1893	Apr. 1	Nov. 15	Mar. 10	Dec. 4	May 15	14.85	Nov. 20	−0.05
1894	Mar. 21	.....	Mar. 1	.....	June 3	11.35	.....	.....

REPORT OF MR. M. MEIGS, U. S. CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1894.

t: I have the honor to submit the following report on "operating and care foines Rapids Canal and Dry Dock" for the fiscal year ending June 30, 1894. anal was open for navigation 238 days and closed 127. A few boats were rough after the regular closing of the canal, the gates being operated by hand. high water occurred during the year, the highest stage, which was reached 5, being 14.85 feet above low water of 1864. From April 1 to June 30 there od stage of water for boats to run outside of the canal, and in consequence ic statement shows proportional reduction in volume. The canal was closed er 15, 1893, and opened March 21, 1894.

s to gates, machinery, and buildings.—During the winter months a cracked c cylinder was removed from the northeast tower at the lower lock and by a new one. Some broken pipe behind the upper outside wing wall of ck was replaced. The repairs to the pipe were costly, as the breaks were me 16 feet below the surface of the ground, and there was much water to with. Soon after closing the canal in 1893, a cofferdam or bulkhead was elow the lower gates of the lower lock, and the lock was pumped out by ion dredge. A careful examination of the culverts and gates below water wed them to be in better condition than was expected. A few leaks in the walls and invert were cemented up. Several broken wicket gates were , and one new culvert gate was put in on the discharge culvert at outside of here badly worn, the slides on which the culvert gates work were repaired opening and closing sheaves under the upper gates were put in good order. ing the length of time this lock has been in operation (seventeen years) the were trifling in amount.

ulkhead used for closing the lower end of the lock was of a rather novel con- , consisting of what is known as a "horse dam," covered by a canvas sheet, de the water. The construction proved to be excellently adapted to its pur- he amount of leakage was extremely small, and the dam was placed and in a fraction of the time required to build a regular plank-and-gravel dam. material, timber, and canvas were practically uninjured, and have since d in various repairs to barges, dump boats, etc. The bulkhead withstood a 12 feet, and under this pressure leaked about as much as one man could pump and pump.

middle lock all four gates were completely rebuilt, except the four bottom of each gate, which were found to be practically as good as new. The tim- in the rebuilding of the gates was Oregon fir, a class of timber coming to use in this part of the country where long timbers are required. The s remarkably sound, free from knots and weak places, and is known to be able. Besides rebuilding the main gates a large amount of repairs was the culvert gates and wicket gates of the lock. One of the aluminum bronze broke at the lower outside column and was replaced.

ril 1 a tow of six barges, loaded with ties, broke loose above the middle ile the lock was filling, and rammed the gates, completely destroying one l breaking a few timbers of the other. Three of the barges sank above the hich greatly added to the difficulty of repairing them, as the barges had to l and removed before anything could be done in the way of replacing the gate. It took nearly a week to raise the barges, transfer the ties, and get out of the canal. The water was let out of the upper level during the night th, and repairs were begun the next morning. The two electric lamps used ing the lock were suspended each side of the broken gate. A derrick was nd the men worked in two shifts, night and day, until the repairs were com- The finished gate was swung the evening of April 13. The work was facilitated by having on hand all the large timber wanted, without which ore time would have been required. It may be noted that had these gates ron, the time required to get the material together and erect the gate would y have been much greater.

s to plant.—The dredge *Phœnix* and towboat *Vixen* received small repairs, large number of dump boats used in the dredging operations. The canal *ijax* was put in the dry dock at the close of navigation in 1893 and wrecked. ull and cabin complete have been built for her, and the machinery trans- the new hull. It is expected that she will be ready for use early in July. dge has served continuously for seventeen years, and has done excellent Very little change was made in the design, as it has worked admirably. re box and new flues were put in the boiler, and the machinery was generally led. Canal dump boats A and C are in process of rebuilding. One of them y finished and the other well advanced. These boats are 10 years old, and *far gone for ordinary repairs.*

Booms above and below the canal.—Two broken chains on the lower lock boom were repaired with the help of a diver. The boom above the guard lock has become water-logged, and will have to be docked next winter, the mud removed from its interior, and repairs made to it.

Cribs above the guard lock.—The two lower cribs above the guard lock, built originally of 3-inch plank, were completely rebuilt during September, 1893. These cribs were 13 years old.

Below the lower lock.—In September, 1893, the lower section of the boom was removed, to permit the Keokuk Water Works Company to extend its pipe out into the channel, it being the opinion of many that the boom cut off the supply of pure water. The new drill boat No. 6, was loaned the company for three days to drill and break the rock underlying the boom, so that the pipe could be laid in a trench below grade. The pipe was successfully laid by divers employed for the purpose, the broken rock having been first removed by dredging, and it is thought no interference between the boom and pipe will ensue, as all stone was carefully removed from both sides of the cut in which the pipe lies.

Machine shop at the lower lock.—During the year the machine shop has been in constant requisition, especially during the winter months. The machine-shop boiler, now 20 years old, received a new forward head and a new set of flues. A very great amount of work has been done to the plant belonging to the canal and to steamers and dredges belonging to the general appropriation. Two small dynamos were built, and also two electric engines. The engines of towboat *Mac* were rebuilt, and a new shaft, etc., built for the launch *Louise*, all the machinery of these boats being thoroughly overhauled. A new cylinder was fitted for the lower-lock northeast tower. All repairs to the middle lock and lower lock gates were cared for. The machinery of dredge *Ajax* was repaired and put in the new hull built for her; also a new engine built for drill boat No. 6 and dynamo and engine set up.

Dredging canal.—During the season of high water, while it was possible to take material on the rapids, dredging has been carried on with one dredge working double shifts. From July 1 to 11, 1893, dredge *Ajax* and towboat *Vixen* were employed, and from April 1 to June 13, 1894, dredge *Phœnix* and towboat *Vixen*. On April 13 the *Phœnix* was transferred to work on the Des Moines Rapids and the *Vixen* to work on the general improvement of the river in the vicinity of Canton, Mo.

The dredging was done mostly about the mouths of the two creeks discharging into the canal. The lower and middle locks were cleaned out and some dredging done at the lower entrance to the canal.

During the fiscal year there have been removed as follows:

From the upper level	cubic yards..	50,042.03
From the lower level	do....	1,405.17
From below lower lock	do....	6,577.75
Total	do....	58,024.95

The advantage of working two shifts on the dredge appears each year more manifest. Not only does the night crew usually take out more material per week, but a healthy competition between the two crews tends to give interest to the work and increase the average output.

Operating dry dock.—The dry dock has been very actively employed during the whole past year. A small sawmill plant was put in. A circular-saw machine was built at the lower-lock machine shop, and a band saw of the Fay and Egan Company make was purchased. These machines have been very useful. The cradle timbers of the dock have been extended to the full length of the dock, adding some 40 feet of available space for docking boats. A very large amount of work has been done repairing the canal property and boats belonging to the general improvement plant. The following is a partial list of boats constructed and repaired:

Built.—One suction dredge (100 by 20 feet); 8 pontons (for carrying discharge pipe of suction dredge), 14 by 32 feet; 1 pile-driver hull and leaders; 3 coal flats; 6 office boats (12 by 32 feet); 1 hull and cabin for dredge *Ajax;* 2 quarter boats (20 by 72 feet); 1 hull for quarter boat; 1 hull and cabin for launch *Louise*; 11 large skiffs (24 to 26 feet long).

Rebuilt.—Two dump boats; 6 model barges.

Repaired.—One launch (*Mac*), heavy repairs. Nominal repairs were made to 15 barges, 7 towboats, 2 dredges, and 2 pile-drivers.

Commenced.—One quarter boat (20 by 72 feet).

Completed.—Four building boats; 1 drill boat; 1 powder boat; 1 magazine boat.

During the past year I have been ably assisted by Mr. John R. Carpenter, acting superintendent, and Mr. O. S. Willey, clerk.

Very respectfully, your obedient servant,

M. MEIGS,
U. S. Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 5.

OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS.

The act of Congress of September 19, 1890, authorized the city of alena to continue and complete the improvement of the Galena River om a point 800 feet below the custom-house at Galena to the Mississippi River. In carrying out the provisions of the act the city was uthorized to construct a dam rising not more than 12 feet above low ater, with a lock not less than 280 feet long and 52 feet wide. In consideration of said improvements the United States promised to pay $100,000 when a channel had been opened and maintained for navigation ne season to a depth of at least 3 feet and of a width sufficient to accommodate any raft or boat that could pass through the lock. The Secretary f War was authorized and directed to draw his warrant on the Treasrer of the United States in favor of the city of Galena, or its representatives, on the receipt of a certificate from the collector of the port f Galena and the local inspectors of steamboats for that district that the conditions of the act had been complied with. This certificate was given in November, 1893, and a report was made by this office December 29, 1893, after a survey of the improvement had been made. The improvement was paid for in March, 1894. This office took charge of the improvement March 12, 1894; a small operating force was appointed and the lock opened to navigation. The expenses of operating and care of the improvement are provided for by act of Congress approved July 5, 1884.

The project for the present fiscal year was submitted March 20, 1894, and approved by the Secretary of War March 26. This project contemplated keeping the lock in readiness for use at all hours of the day or night and the employment of a force of 3 men for operating and care.

The expenses for the fiscal year ending June 30, 1894, were $635.68. The lock was open for navigation from March 12 to April 29, and from une 9 to the end of the fiscal year—a period of seventy days. Between pril 30 and June 8 the lock was flooded and boats passed over the am. There passed through the lock 167 steamboats and barges, carring 1,426 passengers and 1,228 tons of merchandise. It will probay be necessary to make many repairs to lock and dam and to do a rge amount of dredging during the coming year.

Abstract of appropriations.

act approved—	
September 19, 1890	$100,000
July 5, 1884, for fiscal year ending June 30, 1894	500
Total	100,500

Money statement.

30, 1894, amount drawn from Treasury under indefinite appropriation.	$500.00
30, 1894, amount expended during fiscal year	635.68
30, 1894, not received from Treasury	135.68

Expenditures for operating and care of Galena River improvement for fiscal year ending June 30, 1894.

Month.	Superintendence and office expenses.	Labor.	Supplies.	Total.
April	$4.50	$104.67	$1.59	$110.76
May	2.67	340.00	.....	342.67
June	.....	179.00	3.25	182.25
Total	7.17	623.67	4.84	635.68

APPENDIX Z.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA, OF RIVERS IN WISCONSIN AND MINNESOTA TRIBUTARY TO MISSISSIPPI RIVER, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT ST. PAUL.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mississippi River above Falls of St. Anthony, Minnesota.
2. Reservoirs at headwaters of Mississippi River.
3. Chippewa River, including Yellow Banks, Wisconsin.
4. St. Croix River, Wisconsin and Minnesota.
5. Minnesota River, Minnesota.
6. Red River of the North, Minnesota and North Dakota.
7. Gauging Mississippi River at or near St. Paul, Minn.
8. Surveys for reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 10, 1894.

GENERAL: I have the honor to transmit herewith reports * * * upon the works for improvement of rivers and harbors in my charge for fiscal year ending June 30, 1894.

* * * * * * *

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Z 1.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA.

This stretch of river extends from St. Anthony Falls to Grand Rapids, Minn., a distance of 337 miles. The project for improvement and estimates of cost were submitted in Major Farquhar's report on the survey, dated February 8, 1875, and printed on pp. 441–453, Annual Report, Part II, 1875. The report gives two estimates, one for a channel 5 feet deep and one for a channel 3 feet deep. In each case the river was divided into three sections.

Estimate for a channel 5 feet deep at lowest stage of water.

1. Falls of St. Anthony to St. Cloud, 78 miles, construction of wing dams and dredging (estimated cost)	$144,667.50
2. St. Cloud to Conradi Shoals, 42 miles, construction of wing dams, removal of bowlders, and construction of 4 locks and dams (estimated cost)	1,957,783.75
3. Conradi Shoals to Grand Rapids, 217 miles, dredging, removal of bowlders and the construction of wing dams (estimated cost)	54,127.50
Total cost	2,156,578.75

Estimate for a channel 3 feet deep at lowest stage of water.

1. Falls of St. Anthony to St. Cloud, 78 miles, construction of wing dams and dredging (estimated cost)	$75,390.00
2. From St. Cloud to Conradi Shoals, 42 miles, construction of wing dams, removal of bowlders, and construction of 4 locks and dams (estimated cost)	1,943,210.00
3. From Conradi Shoals to Grand Rapids, 217 miles, dredging, removal of bowlders, and the construction of wing dams (estimated cost).	11,620.50
Total cost	2,030,220.50

The project and estimates for the 5-foot channel seem to have been adopted.

The appropriations for 1874 and 1876 were expended on the first section (Falls to St. Cloud). Steamboat navigation having discontinued on that section the third appropriation, that of $15,000, by act of Congress, approved June 14, 1880, was applied to the upper 130 miles (Aitkin to Grand Rapids) of the third section, as have been all subsequent appropriations for improving the river above the Falls of St. Anthony, except the appropriation made by act of Congress approved September 19, 1890, which was applied to the upper 185 miles (Brainerd to Grand Rapids) of the third section. In 1889 the estimate for improving the upper 130 miles (Aitkin to Grand Rapids) of the third section was placed at $63,000, including the $45,000 previously appropriated. In the same report the officer asked for an appropriation of $18,000 to complete the work over this stretch. The amount was given in the act approved September 19, 1890, and subsequently expended in the completion of the necessary improvements, and also in extending navigation from Aitkin to Brainerd, 55 miles.

Before work of improvement commenced under the present plan the stream between Grand Rapids and Aitkin was so obstructed by snags, bowlders, and leaning trees that, at fair stages of water, navigation was difficult, and sometimes almost impossible, for steamers drawing more than 3 feet of water.

The amount expended to June 30, 1893, including outstanding liabilities, $45,000 on first section and $62,994.77 on upper 185 miles of third section. With the latter amount there has been produced a general depth of 3 feet at low water. A few snags, bowlders, and leaning trees offered some obstruction, but did not seriously interfere with navigation. This improvement, though not complete for 5 feet depth as called for in the project, is yet ample for present needs; furthermore, the three completed reservoirs at the head waters of the Mississippi River, above Grand Rapids, may be relied upon to provide sufficient water and depth for the steamboats on the river at and above Brainerd.

There being no demand at present for navigation between Brainerd and Minneapolis, no further appropriation is now asked for. The time will come when this should be done. I will say, in conclusion, that this reach can be placed in excellent navigable condition at quite a reasonable expense.

nount expended during the fiscal year ending June 30, 1894, includ-
outstanding liabilities, $5.23.

st season there was but one steamer on the river. She was engaged
hree months in driving loose logs and the balance of the season
sported freight between Aitkin and Grand Rapids. During the
er of 1889–'90 the Duluth and Winnipeg Railroad Company con-
ted a line from Cloquet, a point on the St. Paul and Duluth Rail-
, to La Prairie. They have since extended their line through and
nd Grand Rapids. This road has reduced the river traffic.

1889, Maj. C. J. Allen reported:

comparative tables of commercial statistics herewith show that in 1880, the
in which the work of improvement between Aitkin and Grand Rapids com-
d, there was but one steamer (with its barges) plying between those points,
hat, though the amount of freight transported that year by steamer was
ally large, the freight rates were from 75 cents to $1 per 100 pounds, while in
1884, 1885, and 1886 the rates were reduced to 20 to 40 cents per 100 pounds.
st-named figures were obtained in 1886, at which time there were three steam-
engaged in freighting and carrying passengers between Aitkin and Grand
s. The country bordering the river north of Aitkin is becoming more and more
l, and there is no doubt that the improvement of the river already effected
U. S. Government has largely contributed to the increase in settlement.

work is in the collection district of Minnesota, of which St. Paul is the port
ry and St. Vincent a subport. Collections for the year ending December 31,
404,865.46; value of domestic exports for same period, $241,195.

Abstract of appropriations.

approved—	
ne 23, 1874	$25,000
igust 14, 1876	20,000
ne 14, 1880	15,000
arch 3, 1881	10,000
passed August 2, 1882	10,000
of August 11, 1888	10,000
approved September 19, 1890	18,000
Total	108,000

Money statement.

1893, balance unexpended	$15.58
), 1894, amount expended during fiscal year	8.18
1894, balance unexpended	7.40
1894, outstanding liabilities	7.40

COMMERCIAL STATISTICS.

ative statement of steamboat business on the Mississippi River between Aitkin and Grand Rapids, 1880–1893, inclusive.

ear.	Steamboats.	Freight carried (general merchandise).	Passengers.	Year.	Steamboats.	Freight carried (general merchandise).	Passengers.
		Tons.				*Tons.*	
	1	3,926	1,000	1887	3	1,855	2,884
	1	1,100	1,540	1888	3	2,650	2,880
	2	1,513	1,764	1889	2	3,500	5,250
	2	1,400	1,100	1890*	1	1,600	1,253
	2	8,000	1,346	1891*	†2	1,500	1,000
	2	2,500	2,400	1892*	†2	1,250	3,000
	3	1,500	3,500	1893*	‡1	401	750

* Amount of navigation and commerce 1890, 1891, 1892, and 1893, approximate.
† Tonnage of steamboats, 140 and 185 tons, respectively.
‡ Tonnage of steamboat, *140 tons.*

Comparative statement of loose logs run on the Mississippi River above the Falls of St. Anthony.

Year.	Loose logs run.	Year.	Loose logs run.
	Feet, B. M.		*Feet, B. M.*
1880	226, 000, 000	1887	*265, 000, 000
1881	238, 000, 000	1888	*265, 000, 000
1882	285, 000, 000	1889	288, 000, 000
1883	420, 000, 000	1890	325, 669, 295
1884	367, 000, 000	1891	425, 716, 970
1885	317, 993, 000	1892	*520, 000, 000
1886	282, 600, 000	1893	398, 000, 000

*Approximate.

Z 2.

RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendixes to various annual reports of the Chief of Engineers. The résumé of the subject is given in the Report of the Board of Engineers, printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted, and further examinations in 1880, the first cost of constructing 41 reservoir dams in Minnesota and Wisconsin was placed at $1,809,083.50, exclusive of that of land damages, which could not be given in advance. (See p. 1762, Appendix W, to the Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winnibigoshish, made by act of Congress approved June 14, that year. For the reasons given in the Annual Report for 1886 the work of construction was commenced and has been continued in Minnesota.

The project has for its object the construction and maintenance of reservoirs at the head waters of the Mississippi River, in the State of Minnesota, for the purpose of collecting the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected.

There are four completed reservoirs, viz:

At Lake Winnibigoshish, completed in 1883–'84; capacity, 45,800,000,000 cubic feet.

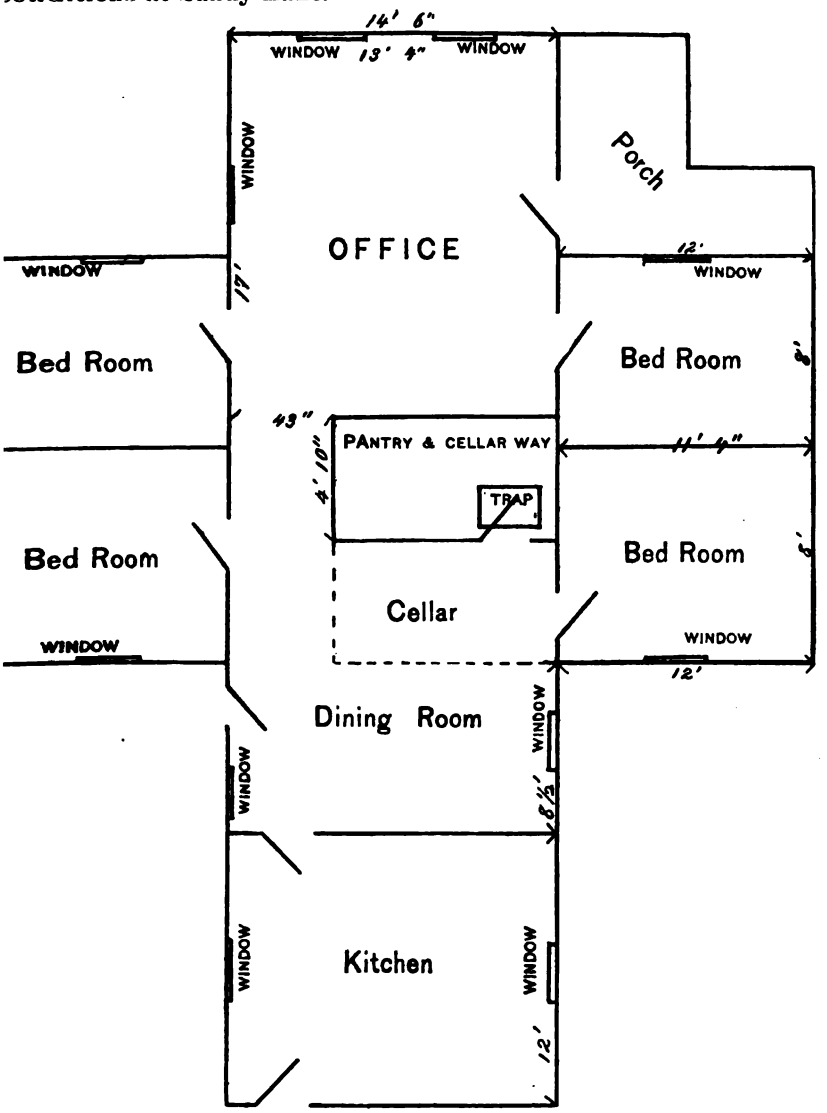
At Leech Lake, completed in 1884; capacity, 30,000,000,000 cubic feet.

At Pokegama Falls, completed in 1884; lift of dam increased in 1889; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; capacity, 7,500,000,000 cubic feet.

Rules and regulations to control the use and administration of the reservoirs were formulated and approved by the Secretary of War February 21, 1889, as authorized by the river and harbor act of August 11, 1888. Gaugings of the Mississippi River at St. Paul, to determine

ffects of reservoir water, have been made to a limited extent during ›ast four years. They form the subject of a separate report.
ıring May and June, 1891, men and materials for constructing a reservoir at Sandy Lake were assembled and the work of construc- soon after commenced. The original plans for this dam were sim- to those of the four dams previously constructed, but adapted to :onditions at Sandy Lake.



river and harbor act of Congress, approved July 13, 1893, appro- d "for care and maintenance of reservoirs at the head waters of ississippi River, $60,000, of which $30,000 may be expended for nstruction of a navigable pass through Sandy Lake Dam." s provision *delayed the* completion of the dam. The portion,

about one-half the length, that was not affected by the change was practically completed in the fall of 1892.

Amount expended upon this work, including examination at proposed dam sites, hydrological observations, land damages, amounts paid to commissioners in attempted settlement of awards to Indians, and care and maintenance of the works to the close of the fiscal year ending June 30, 1893, $727,799.67.

SANDY LAKE DAM.

Progress report to June 30, 1894.

Work was commenced on July 1, 1891. The following has been done:

Buildings constructed:	Feet.
Laborers' quarters	20 by 48
Dining room and kitchen	20 4¼
Warehouse	20 3⅙
Carpenter shop	20 3⅙
Blacksmith shop	18 3⅓
Tool house	14 3½
Stable; 5 double, 2 single stalls	30 3½

House for watchmen's quarters of dimensions shown in diagram below. Size of doors, 2 feet 8 inches by 6 feet 8 inches; window, 4 lights, 12 by 30 inches; ceiling 9½ feet high in all rooms except kitchen, which is 8½ feet. The roof is dropped 1 foot accordingly.

All the buildings are one story high and shingled, balloon frames, with the exception of the watchmen's quarters; they are finished with rough boards of inch lumber. The watchmen's quarters are finished with planed lumber and plastered. It rests on oak blocks. The cellar is lined with 6 by 12 inch timber.

COFFERDAM.

The cofferdam is composed of two rows of round piles, 12 feet from center to center of piles, with the exception of 62 feet of the east end of the upper part, where they were driven 14 feet from center. The

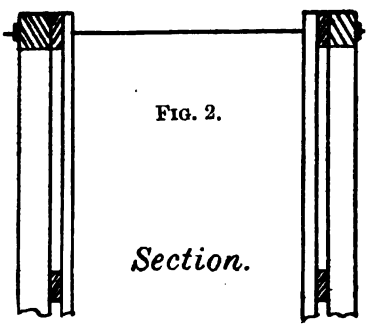


FIG. 2.

Section.

piles in each row are 8½ feet from center to center, cut off at an elevation of 1,217 feet above the sea level, and capped with 12 by 12 inch timber. The inside row of sheeting is 4 by 12 inch, and the outside 6 by 12 inch plank. The sheeting is cut off at an elevation of 1,218 feet above sea level, or 2 feet below the flowage line. One-inch rods of round iron 8½ feet apart pass through the caps to prevent the filling from spreading the two lines of sheeting at the top.

In May, 1892, when a flood occurred, the outside of the cofferdam was raised 3 feet by splicing 3-inch plank to the outside row of sheet-

ing and then filling the triangular prism thus formed with earth. Fig. No. 2 will give an idea of the cofferdam, not on the floor of the dam. Fig. No. 3 shows a side view of the part of the cofferdam which rests on the floor of the dam. The frames of No. 3 are connected by 1-inch lateral rods of iron.

The total length of cofferdam is 829 feet, of which 742 feet is like that shown in Fig. No. 2, and 87 feet like that shown in Fig. No. 3. These measurements are along the center lines.

Of the portion constructed as in Fig. No. 2, 357 linear feet has been removed, leaving 472 linear feet to be removed when the dam is completed.

ROUND PILES IN DAM.

The number of round piles driven in the foundation is 1,605. The following is a record of the same:

The driving was commenced on November 12, 1891, and completed on August 21, 1893.

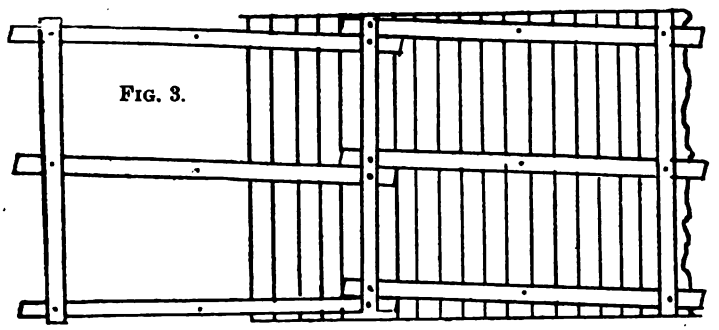


FIG. 3.

The material in the foundation is sand, excepting in the lower and right-hand corner, where there is some blue clay overlaying the sand.

The sand in the foundation is not as compact as it is usually found in the bed of streams. In the south half of the dam the surface settled from 4 to 6 inches during the driving. As the surface was settling the driving was becoming harder all the time. In the north half, which embraces the navigable pass, there was some settlement, but it was not as noticeable as in the south half. The surface had probably settled by the jarring of the hammers while the first half was being driven. The penetration of the piles is also greater than it is usually in sand foundations in the bed of streams.

The piles were all of Norway pine and well seasoned.

Two Munday steam hoisting engines were used in driving, one a single cylinder and the other a double cylinder engine. In operating the hammer, an inch and a half manila rope was attached to the pin connecting the lugs of the hammer, there passed over the sheave at the top of the leaders, and next around the drum of the hoisting engine. When the hammer falls, it pulls the rope with it and unwinds it from the drum. This is what is termed driving with a "slack line." The blow is not as effective as if the hammer was dropped from nippers, but the blows are more rapid, and this partially compensates for the loss of power in pulling the line after it by keeping the material around the piles looser than it would be in the case of using nippers. Iron rings of $\frac{5}{8}$-inch by $2\frac{1}{2}$ inches Norway iron were used to protect the head of the pile.

It is a well-known fact in pile-driving that it is very important to keep the material from settling around the pile, once it has been loosened, until the pile is down; for when the material has settled, or even partially, the penetration is diminished.

The greatest load on a bearing pile is about 13½ tons.

SHEET PILING.

Sheet piling was driven by a pile-driver assisted by a jet of water from a steam force pump. In driving all sheet piles a cast-iron cap or follower was used which fitted over the head of the pile. On the upper side of the follower there is a wooden block of some seasoned and close-grained wood which receives the blow of the hammer. This device saves the head of the pile from being battered or splintered, and the pile can be driven to a greater depth than it could be without it.

In first using the jet on a sheet pile, a groove was made in the inner edge to receive a half-inch gas pipe which was connected with the force pump by means of an inch and a half hose. The aperture at the lower end of the gas pipe was reduced to a diameter of about three-eighths inch. The water was thus forced to the bottom of the pile, and the sand loosened. This worked well until the sheet pile struck gravel, when the nozzle of the pipe would become battered or filled with gravel. The pressure in the hose would then burst a coupling somewhere. Another source of trouble was the frequent breakages in the connection between the pipe and the hose on account of the jarring of the hammer. This plan after awhile was abandoned and the nozzle of the pipe was thrust by hand under the point of the pile. The piles are driven in the ground from 12 to 14 feet. The number of sheet piles driven is 563, equal to 54,048 feet, B. M.

Pine sheeting in dam.

	Feet, B. M.
813 pieces, 6 by 12 inches by 16 feet	78,046
28 pieces, 5 by 12 inches by 16 feet	2,240
352 pieces, 4 by 12 inches by 16 feet	16,896
326 pieces, 3 by 12 inches by 8 feet	7,824
Total	105,006

Timber in place.—The amount of timber put in place, including booms and boom piers, is 792,400 feet, B. M.

Excavation of foundation.—The amount excavated was 5,926 cubic yards.

Filling between and under caps and behind piers.—The amount was 3,827 cubic yards.

Rock.—The amount of rock in place is 3,513 cubic yards.

Brush.—The amount of brush in place is 28 cubic yards.

Concrete.—In making the concrete, Louisville cement was used. The proportions used were 1 part cement, 2 parts sand, and 4 parts gravel. The gravel was from a half-inch to 1 inch in diameter. The amount of concrete put in place was 132 cubic yards.

Dike.—The diaphragm of the dike was formed by driving two rows of 1 by 12 inch boards close together and breaking joints. They were driven in the ground about 3 feet, and were cut off 1 foot above the flowage line.

Length of dike	feet..	640
Timber in diaphragm	feet, B. M..	6,064
Embankment	cubic yards..	2,454

The quantity of embankment includes a 6-inch coating of sod.

Materials remaining on hand.—The amount of rock at the dam is 1,611 cubic yards.

Pine timber not sized.

	Feet, B. M.
3 pieces, 12 by 12 inches by 22 feet	792
1 piece, 12 by 12 inches by 18 feet	216
18 pieces, 12 by 12 inches by 16 feet	3,456
8 pieces, 12 by 12 inches by 14 feet	1,344
7 pieces, 9 by 9 inches by 20 feet	945
6 pieces 6 by 12 inches by 24 feet	864
127 pieces 6 by 12 inches by 16 feet	12,192
2 pieces 6 by 12 inches by 14 feet	168
12 pieces 6 by 6 inches by 12 feet	432
40 pieces 4 by 12 inches by 12 feet	1,920
3 pieces 3 by 12 inches by 30 feet	270
21 pieces 3 by 12 inches by 20 feet	1,260
352 pieces 3 by 12 inches by 16 feet	16,896
202 pieces 3 by 12 inches by 14 feet	8,484
79 pieces 3 by 12 inches by 12 feet	2,844
27 pieces 2 by 12 inches by 12 feet	648
2 pieces 2 by 4 inches by 16 feet	21
16 pieces 1 by 12 inches by 16 feet	256
139 pieces 1 by 12 inches by 12 feet	1,668
Total	54,676

Pine timber, sized.

40 pieces 8 by 12 inches by 14 feet	4,480
40 pieces 9 by 12 inches by 14 feet	5,040
40 pieces 9 by 12 inches by 16 feet	5,766
39 pieces 8 by 12 inches by 18 feet	5,610
160 pieces 11 by 12 inches by 20 feet	35,200
Total	56,096

Oak.

1 piece 12 by 14 inches by 30 feet	420
4 pieces 3 by 12 inches by 20 feet	240
84 pieces 4½ by 12½ inches by 12 feet	4,725
53 pieces 2 by 12 inches by 16 feet	1,696
7 pieces 3 by 12 inches by 16 feet	336
Total	7,417

Timber in cofferdam to be extracted and used.

12 by 12 inches	8,496
80 pieces 6 by 12 inches by 22 feet	10,560
406 pieces 6 by 12 inches by 18 feet	43,848
239 pieces 4 by 12 inches by 16 feet	15,296
12 pieces 3 by 12 inches by 28 feet	1,008
174 pieces 3 by 12 inches by 12 feet	6,264
Total	85,472

Iron.

Common:	Pounds.
1-inch round	6,290
⅞-inch round	1,937
¾-inch round	2,777
⅝-inch round	1,037
½-inch round	351
⅜-inch round	20
¼-inch round	25
1¼ inches round	358
1-inch square	40
4½ by 1¼ inches flat	128
3 inches by $\frac{3}{16}$ inch	1,092
3 by ¼ inch	61
Total common iron	14,116
Norway:	
2½ inches by ⅝ inch flat	158
2½ inches by ½ inch flat	328
2 inches by ½ inch flat	106
1 inch by ½ inch flat	67
¾ inch square	103
⅞ inch round	138
1 inch round	173
Total Norway iron	1,073

Steel.

2 inches square	85
1½ inches square	138
1-inch square	19
¾-inch octagon	52
¾-inch round	130
½-inch round	25
1-inch round	39
Total	488

Spikes and nails.

Boat spikes:	
13 inches by ½ inch	2,000
7 inches by ⅝ inch	1,528
9 inches by ½ inch	799
6 inches by ⅝ inch	538
5 inches by ⅝ inch	440
Total	5,305
Steel cut nails:	
8-penny	200
10-penny	2
40-penny	20
Total	242

Materials required for completion.

The amount of timber required is as follows:

	Feet, B. M.
60 pieces 12 by 12 by 12 inches	8,640
30 pieces 12 by 12 by 14 inches	5,040
115 pieces 12 by 12 by 16 inches	22,080
8 pieces 12 by 12 by 20 inches	1,920
4 pieces 12 by 12 by 22 inches	1,056
	38,736
42 pieces 2 by 12 by 12 inches	1,008
167 pieces 1 by 12 by 12 inches	2,004
Total	41,748

Iron.

Common:	Pounds.
1-inch round	6,290
⅞-inch round	1,937
¾-inch round	2,777
⅝-inch round	1,037
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⅜-inch round	20
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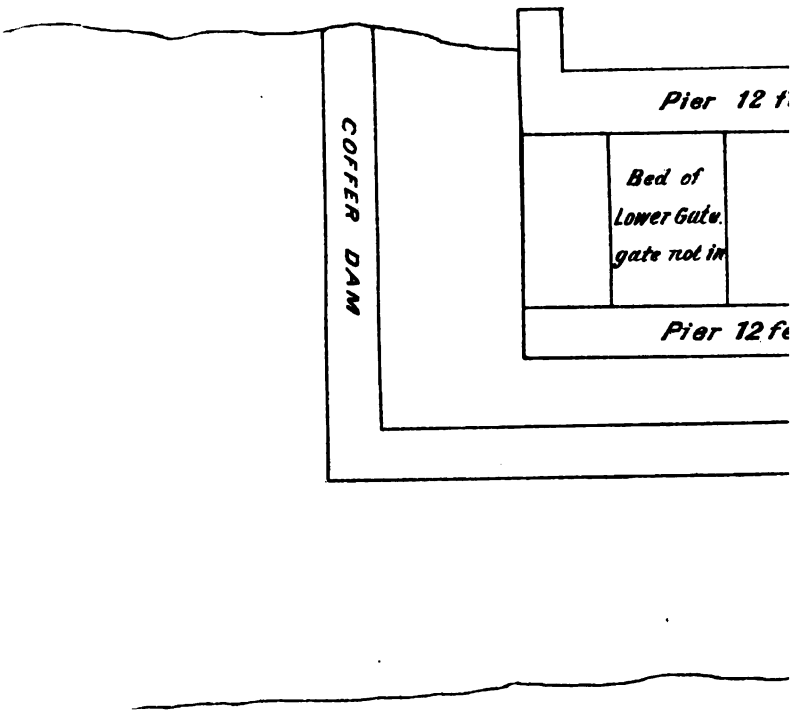


Conditio

OPERATIONS DURING THE PAST FISCAL YEAR.

y Lake Dam.—It was June 30, 1893, before the plans for the ble pass were approved. Construction work was resumed at nd pushed with vigor until January, 1894, when operations were ded for want of funds to continue.

condition of the Sandy Lake Dam is as follows:

structure, exclusive of the navigable pass, is complete, except ng the slide gates of the five small discharge sluices. The nes for manipulating the latter are on hand but not in position. p of the crib work back of the small sluices remains to be planked

The navigable pass is inclosed by a cofferdam, the top of which feet below the flowage line. In the meantime the discharge gs are confined to one log sluice 11 feet wide, open the full height n, and three sluices, 4 by 5 feet area, on a level with the floor of

The log sluice is opened and closed by an improved bear-trap

The small sluices are, for the present, worked by stop plank.

navigable pass will be finished when the piers are raised 5 igher. The walls for a height of 12 feet above the floor are to be ed. The gates are to be built and the earth between the pier and is to be put in. The ironwork, except valves for the gates, are nd. The piers of the pass are filled with rock to their present t.

en the navigable pass shall have been finished it is intended to for releasing water as well as for the passage of boats.

drawing herewith shows the condition of work at Sandy Lake

GENERAL.

addition to the construction work at Sandy Lake Dam the 4 eted reservoirs were maintained and operated. Maps of the oir watersheds were prepared and the hydrological and meteoro- l data were tabulated.

table herewith shows the capacity and areas of the reservoirs, sheds, evaporating surfaces, etc., of the Mississippi River above aul, Minn.

THE GREAT RESERVOIRS OF THE MISSISSIPPI.

Capacity and areas of reservoirs, watersheds, evaporating surfaces, etc., Mississippi River above St. Paul, Minn.

	Working height of dam above low water.	Capacity of reservoir.	Areas of reservoirs.		Areas of other lakes, etc., in the same basin.	Area of watersheds.	Area of watersheds, less all evaporating surfaces.	
			High water.	Low water.			Reservoir empty.	Reservoir full.
	Feet.	*Cubic feet.*	*Square miles.*	*Square miles.*	*Square miles.*	*Square miles.*	*Square miles.*	*Square miles.*
Winnibigoshish*	14	45,813,941,344	161.26	117.00	94.60	1,442.43	1,230.83	1,186.57
Leech Lake	6	30,018,150,835	233.80	173.19	75.50	1,162.80	914.11	853.50
Pokegama Lake	9	41,683,070,525	45.29	† 24.13	‡ 30.84	660.23	599.26	578.10
Pine River	17	7,474,384,104	23.76	18.30	40.00	562.07	500.77	498.31
Sandy Lake	7	2,085,895,000	16.52	8.00	18.00	421.50	395.50	386.98
Prairie River					47.00	497.27	§ 432.27	432.27
Swan River					15.00	324.45	§ 309.45	309.45
Mississippi River (above Crow Wing)					142.00	2,039.06	§ 1,997.06	1,997.06
Gull Lake	8	5,960,923,158	35.43	33.33	5.00	287.22	225.75	220.86
Crow Wing River					144.00	3,321.49	§ 3,177.49	3,177.49
Mille Lacs				190.00	9.00	406.20	207.20	207.20
Rum River					40.00	1,071.77	§ 1,031.77	1,031.77
Sauk River					52.00	984.67	§ 932.67	932.67
Platte River					8.00	399.51	§ 391.51	391.51
Elk River					15.00	688.56	§ 653.56	653.56
Crow River					160.00	2,806.79	§ 2,646.79	2,646.79
Mississippi River (above St. Paul and below)					142.50	2,673.32	§ 2,530.82	2,530.82
Minnesota River (above Mendota					524.00	16,350.00	§ 15,826.00	15,826.00
Minnesota River (above Chaska)					500.00	16,000.00	§ 15,500.00	15,500.00

	Cubic feet.
Total capacity of the four completed reservoirs	87,989,546,808
Capacity of the Sandy Lake Reservoir now being built	2,085,895,000
Capacity of the projected reservoir at Gull Lake	5,960,923,158
Prospective total	96,036,364,966

	Square miles.
Watershed of the Mississippi River above Crow Wing River	7,107.78
Watershed of the Crow Wing River	3,608.71
Watershed of the Mississippi River below Crow Wing River	9,014.22
Watershed of the Minnesota River	16,350.00
Total above St. Paul	36,080.71

	Working height of dam above low water.	Capacity of reservoir.
	Feet.	*Cubic feet.*
* Winnibigoshish and Cutfoot Sioux	14	30,493,951,448
* Ravens Point Lake	13	886,678,656
* Cass Lake, etc	4	4,259,819,520
* Cass Lake Swamp	2	295,511,040
* Mississippi River	8	669,081,600
* Winnibigoshish Swamp	10	8,363,520,000
* Lake and swamp in T. 146, R. 26 N	6	251,205,000
* Cutfoot Sioux Swamp	8	594,173,440

	Square miles.
† Pokegama Lake	12.20
Stephens Lake, Whiteoak Lake	3.03
Ball Club Lake	8.90
	24.13
‡ Mud Lake	6.84
Other lakes	30.00
	36.84

§ *No sites* examined for reservoirs on these watersheds.

I.—*Amount of rainfall at Leech Lake, Lake Winnibigoshish, and Pokegama Falls dams during the years 1885 to 1893, inclusive.*

LEECH LAKE DAM.

ear.	Months.												Total for year.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
.....	0.33	0.10	0.40	2.87	2.10	6.60	4.09	3.02	1.53	0.63	0.76	0.30	22.74
.....	1.09	0.82	0.19	2.69	1.70	4.82	1.36	2.64	4.31	1.43	1.59	0.30	22.94
.....	1.02	0.67	0.53	1.52	2.26	5.77	4.46	1.92	1.48	2.48	0.55	2.03	24.69
.....	1.16	0.28	1.67	1.80	1.02	10.23	5.63	0.94	1.48	2.37	0.70	0.22	27.50
.....	0.97	1.09	0.93	1.96	1.35	1.63	4.58	3.81	2.89	0.34	0.92	1.12	21.59
.....	0.63	0.95	0.63	1.20	2.98	4.74	5.29	2.73	3.44	2.59	0.41	0.17	25.76
.....	0.42	1.35	1.41	0.94	1.13	3.57	5.23	3.07	3.43	0.84	0.60	2.09	24.08
.....	0.35	0.69	1.65	2.62	6.00	2.07	3.26	3.78	0.80	0.18	1.49	0.21	23.10
.....	1.35	1.01	1.78	3.49	2.07	1.81	3.80	4.17	1.54	0.84	1.09	1.11	24.06
al 9 years..	7.32	6.96	9.19	19.09	20.61	41.24	37.70	26.69	20.93	11.70	8.11	7.55	216.46
an	0.81	0.77	1.02	2.12	2.29	4.58	4.19	2.90	2.32	1.30	0.90	0.84	24.05

LAKE WINNIBIGOSHISH DAM.

.....	0.46	0.11	0.31	3.26	1.68	7.90	6.22	4.58	2.09	0.65	0.61	0.48	28.35
.....	1.32	1.26	0.26	3.48	2.32	4.20	1.97	3.36	4.84	1.79	1.71	0.29	26.80
.....	1.10	0.83	0.59	1.64	1.58	5.56	4.40	2.56	0.84	3.03	0.64	1.93	24.70
.....	1.27	0.26	1.45	1.83	2.22	10.81	4.07	1.04	1.01	1.89	0.77	0.17	26.79
.....	1.32	1.18	0.82	1.83	0.85	2.14	3.64	4.18	2.85	0.25	1.03	1.26	21.35
.....	0.56	1.01	0.82	0.54	2.56	5.19	2.74	2.88	4.74	2.55	0.40	0.30	24.29
.....	0.57	1.24	1.10	1.32	1.49	3.81	5.47	2.46	4.34	1.25	0.63	1.70	25.38
.....	0.54	0.65	2.23	2.87	4.99	1.32	1.79	2.64	2.40	0.21	1.22	0.12	20.98
.....	0.92	1.25	1.51	2.90	2.60	1.86	4.48	5.46	1.80	1.09	1.32	0.72	25.91
tal 9 years .	8.06	7.79	9.09	19.67	20.29	42.79	34.78	29.16	24.91	12.71	8.33	6.97	224.55
ean.....	0.90	0.87	1.01	2.19	2.25	4.75	3.86	3.24	2.77	1.41	0.93	0.77	24.93

POKEGAMA FALLS DAM.

.....	0.34	0.11	0.60	2.85	2.20	6.29	4.36	2.75	1.89	0.93	0.81	0.53	23.66
.....	1.53	1.49	0.40	2.68	1.58	6.12	0.97	2.49	4.67	2.02	1.57	0.42	25.94
.....	1.00	0.71	0.59	0.87	3.49	5.36	5.29	2.37	1.58	2.81	0.73	2.65	27.45
.....	1.13	0.45	1.93	2.17	2.75	0.39	3.97	0.76	1.56	1.68	1.16	0.19	27.14
.....	1.34	1.61	1.34	1.82	1.18	2.08	4.32	6.21	2.71	0.31	1.30	1.43	25.65
.....	0.65	0.95	0.21	1.27	1.76	7.42	2.64	3.16	3.91	2.81	0.59	0.26	25.63
.....	0.84	1.63	1.37	0.95	0.59	4.53	5.24	2.17	3.87	1.27	0.90	1.66	25.02
.....	0.51	0.57	1.21	2.69	5.12	1.35	2.09	3.55	1.20	0.28	1.38	0.24	20.19
.....	1.62	1.39	1.35	2.87	2.17	3.22	5.70	4.04	1.23	0.69	0.92	1.04	26.24
Total 9 years..	8.96	8.91	9.00	18.17	20.84	45.76	34.58	27.50	22.62	12.80	9.36	8.42	226.92
Mean	1.00	0.99	1.00	2.02	2.32	5.08	3.84	3.06	2.51	1.42	1.04	0.94	25.21

an and annual rainfall for three dams, 24.737 inches.

BLE II.—*Amount of water liberated from Pokegama Falls Dam, and the average monthly and yearly discharge during the years 1885 to 1893, inclusive.*

Year.	January.		February.		March.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Average discharge per second.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
.....	950,375,808	354.83	933,091,488	585.70	891,804,384	332.96
.....	1,578,553,920	589.36	1,365,552,864	564.46	1,036,920,096	387.14
.....	1,353,198,528	505.23	861,746,688	356.21	806,906,016	301.26
.....	1,363,894,848	509.22	1,234,058,400	492.88	906,135,552	338.31
.....	1,317,272,544	491.81	1,199,510,208	495.83	781,993,440	291.96
.....	1,366,223,328	510.09	1,163,058,912	480.70	589,423,392	220.06
.....	723,632,832	270.17	344,623,680	142.45	370,690,560	138.40
.....	755,273,376	281.98	945,311,040	377.28	794,945,664	296.80
.....	879,066,720	328.54	803,975,328	332.33	403,901,856	150.78
Total 9 years.....	10,288,391,904	.....	8,851,828,608	.....	6,582,720,960	.....
Mean	1,143,154,656	426.80	983,536,512	403.35	731,413,440	273.08

TABLE II.—*Amount of water liberated from Pokegama Falls Dam, and the average monthly and yearly discharge during the years 1885 to 1893, inclusive*—Continued.

Year.	April.		May.		June.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Average discharge per second.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
1885	665,627,328	256.80	2,280,455,552	843.95	3,234,076,416	1,247.71
1886	1,263,809,952	487.58	2,699,517,024	1,007.88	4,608,569,952	1,778.80
1887	696,665,664	268.77	2,434,639,680	908.99	2,521,337,760	972.74
1888	900,271,584	347.32	2,410,363,872	899.93	6,988,908,096	2,696.33
1889	1,680,960,384	648.52	3,290,886,144	1,228.68	3,641,382,432	1,404.85
1890	420,431,040	162.20	2,457,323,136	917.45	2,353,631,040	908.02
1891	353,685,312	136.45	1,837,118,880	685.90	2,503,541,952	965.87
1892	831,566,304	320.82	1,216,572,480	454.21	2,224,182,528	858.09
1893	358,482,240	138.30	844,242,048	315.20	1,585,690,560	611.76
Total, nine years	7,171,499,808	.....	19,451,118,816	.....	29,661,320,736	.....
Mean	796,833,312	307.42	2,161,235,424	806.91	3,295,702,304	1,271.48

Year.	July.		August.		September.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Average discharge per second.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
1885	2,827,486,656	1,055.66	5,323,588,704	1,987.60	7,920,343,296	3,055.68
1886	4,287,609,504	1,600.81	6,151,680,000	2,296.77	6,511,789,152	2,512.36
1887	2,438,520,768	910.44	4,209,889,248	1,571.79	4,706,300,448	1,815.70
1888	6,515,052,960	2,432.66	3,746,912,256	1,398.93	6,703,877,952	2,586.37
1889	4,967,177,472	1,854.53	5,525,859,744	2,063.12	3,970,571,616	1,531.85
1890	2,613,098,880	975.62	3,144,755,232	1,174.11	3,324,917,376	1,282.76
1891	2,565,612,576	957.89	3,510,753,408	1,310.76	4,090,468,032	1,578.11
1892	2,488,837,088	929.15	3,707,300,448	1,384.14	4,362,049,152	1,682.89
1893	2,607,990,048	973.71	3,882,079,872	1,449.40	7,107,537,888	2,742.65
Total, nine years	31,311,785,952	.....	39,202,818,912	.....	48,697,854,912	.....
Mean	3,479,087,328	1,298.94	4,355,868,768	1,626.29	5,410,872,768	2,087.52

Year.	October.		November.		December.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Average discharge per second.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
1885	7,187,035,872	2,683.55	2,941,089,696	1,134.68	1,852,106,688	691.49
1886	5,042,297,088	1,882.57	2,758,228,416	1,064.13	1,535,344,416	573.23
1887	3,959,332,704	1,478.25	2,112,060,096	814.84	1,421,511,552	530.73
1888	7,963,594,272	2,973.26	4,710,695,616	1,817.40	1,330,973,856	496.93
1889	4,384,196,064	1,636.87	2,318,698,656	894.56	1,284,584,832	479.69
1890	3,330,872,064	1,243.60	1,424,366,208	549.52	703,732,320	262.74
1891	3,582,669,312	1,337.61	1,375,814,592	530.79	1,062,126,432	396.55
1892	4,082,665,248	1,524.29	2,418,666,048	933.11	1,200,478,752	448.27
1893	7,512,146,496	2,804.71	2,828,491,488	1,091.12	1,105,271,136	412.66
Total, nine years	47,045,409,120	.....	22,888,110,816	.....	11,496,129,964	.....
Mean	5,227,267,680	1,951.71	2,543,123,424	981.14	1,277,347,776	476.97

TABLE II.—*Amount of water liberated from Pokegama Falls Dam, and the average monthly and yearly discharge during the years 1885 to 1893, inclusive*—Continued.

Year.	Total amount for year.	Average discharge per second.
	Cubic feet.	*Cubic feet.*
1885	36,987,681,888	1,172.87
1886	38,839,872,384	1,231.60
1887	27,522,109,152	872.72
1888	44,776,239,264	1,415.96
1889	34,363,093,536	1,089.64
1890	22,891,832,928	725.89
1891	22,320,737,568	707.78
1892	25,027,648,128	791.45
1893	29,919,775,680	948.88
Total, nine years	282,648,990,528	.....
Mean	31,405,443,392	995.26

Area of watersheds of Leech Lake, Lake Winnibigoshish, and Pokegama Falls reservoirs, 3,265.46 square miles = 91,035,800,064 sqnare feet.

Total rainfall during the years 1885 to 1893, inclusive = 18.5536 feet, or 1,689,041,820,067 cubic feet on the watersheds.

Excess in the reservoirs on December 31, 1893, over the amount on hand on December 31, 1884, 1,587,716,698 cubic feet.

Total liberated at Pokegama Falls Dam during the years 1885 to 1893, inclusive, 282,648,990,528 cubic feet.

Assuming that the surplus, 1,587,716,698 cubic feet, will pass through Pokegama Falls Dam, the total available from the rainfall will be 284,238,435,226 cubic feet.

The percentage of the rainfall which therefore passes Pokegama Falls Dam is 16.828.

TABLE III.—*Amount of rainfall at Pine River Dam during the years 1887 to 1893, inclusive.*

Year.	Months.												Total for year.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1887	.....	.....	.....	.....	1.99	4.60	5.94	2.27	0.33	3.02	0.36	1.87	20.38
1888	1.14	0.25	1.53	2.81	2.52	8.26	3.45	1.76	1.82	1.96	1.32	0.14	26.96
1889	0.94	0.66	1.34	2.30	1.78	0.91	2.55	6.72	2.17	0.00	0.58	0.78	20.73
1890	0.55	0.42	0.63	2.31	2.98	2.56	2.57	2.80	1.90	2.62	0.34	0.18	19.86
1891	0.55	1.26	1.49	1.85	0.89	3.25	2.00	3.15	2.85	0.64	0.83	1.09	19.85
1892	0.22	0.78	0.53	2.51	5.64	2.25	3.42	4.95	0.57	0.33	0.46	0.27	21.93
1893	1.88	0.62	0.94	3.00	3.59	3.91	3.31	5.15	1.41	0.81	0.60	0.85	26.07
Total, 6¾ years	5.28	3.99	6.46	14.78	19.39	25.74	23.24	26.80	11.05	9.38	4.49	5.18	155.78
Mean	0.88	0.66	1.08	2.64	2.77	3.68	3.32	3.83	1.58	1.34	0.64	0.74	22.981

TABLE IV.—*Amount of water liberated from Pine River Dam and the average monthly and yearly discharge during the years 1886 to 1893, inclusive.*

Year.	January.		February.		March.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Average discharge per second.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*
1886	.....	.....	.....	.....	.....	.....
1887	124,544,736	40.49	117,310,464	48.49	74,766,240	27.91
1888	126,323,712	47.16	121,118,112	48.34	134,186,976	50.09
1889	231,793,920	86.54	202,754,880	83.81	234,646,848	87.60
1890	120,165,120	44.86	112,806,432	46.63	64,054,368	23.91
1891	69,028,416	25.57	54,609,984	22.57	63,930,816	23.87
1892	63,482,400	23.70	60,727,104	24.23	67,304,736	25.12
1893	312,764,544	116.77	130,651,488	54.00	148,602,816	55.48
Total, 7¾ years	1,048,102,848	.....	799,978,464	.....	787,492,800	.....
Mean	149,728,978	55.90	114,282,638	46.76	112,498,971	42.00

TABLE IV.—*Amount of water liberated from Pine River Dam and the average mon and yearly discharge during the years 1886 to 1893, inclusive*—Continued.

Year.	April.		May.		June.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Aver discha per secon
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic fret.*	*Cubic*
1886	124, 407, 321	48. 02	627, 905, 952	234. 43	1, 479, 250, 080	57
1887	65, 048, 832	25. 09	171, 168, 768	63. 90	441, 529, 920	17
1888	117. 351, 936	45. 27	465, 646, 752	173. 85	513, 348, 192	19
1889	232, 579, 296	89. 73	311, 229, 216	116. 20	801, 220, 896	30
1890	65, 401, 344	25. 23	63, 467, 712	23. 69	307, 135, 584	11
1891	40, 232, 160	15. 52	185, 523, 264	69. 26	676, 003, 104	26
1892	60, 322, 176	26. 74	416, 039, 328	155. 33	558, 297, 152	21
1893	153, 546, 624	59. 24	248, 461, 344	92. 76	447, 694, 560	17
Total, 7¾ years	867, 949, 689	.....	2, 489, 442, 336	.....	5, 224, 579, 488	.....
Mean	108, 493, 711	41. 85	311, 180. 292	116. 18	653, 072, 436	25

Year.	July.		August.		September.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Aver discha per secon
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic*
1886	931, 736, 736	304. 78	714, 229, 920	266. 66	545, 528, 736	21
1887	1, 149, 613, 344	429. 21	1, 495, 320, 480	558. 28	899, 462, 016	34
1888	754, 600, 800	281. 75	100, 563, 120	37. 55	1, 294, 074, 144	49
1889	1, 761, 038, 496	657. 49	1, 231, 676, 928	459. 85	584, 511, 552	22
1890	702, 873, 120	284. 82	219, 663, 360	82. 01	749, 086. 272	28
1891	1, 060, 709, 472	396. 02	1, 315. 678, 464	491. 21	630, 899, 712	24
1892	593, 806, 464	221. 72	879, 616, 800	328. 41	838, 471, 392	32
1893	246, 964, 032	92. 25	882, 785, 952	329. 59	2, 034, 855, 648	78
Total, 7¾ years	7, 261, 402, 464	.....	6, 839, 535, 024	.....	7, 576, 889, 472	.....
Mean	907, 675, 308	338. 88	854, 941, 878	319. 20	947, 111, 184	36

Year.	October.		November.		December.	
	Amount.	Average discharge per second.	Amount.	Average discharge per second.	Amount.	Aver dischi per secon
	Cubic feet.	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*	*Cubic*
1886	106, 652, 160	39. 82	119, 991, 456	46. 20	124, 619, 904	4
1887	409, 943, 808	153. 50	.....	.....	122, 614, 560	4
1888	1, 540, 560, 384	575. 18	747, 298, 656	288. 31	211, 164, 192	7
1889	388, 717, 920	145. 13	122, 699, 232	47. 33	106, 504, 416	3
1890	1, 079, 913, 600	403. 19	648, 341, 280	250. 13	308, 236, 320	11
1891	469, 541, 664	175. 30	10, 839, 744	4. 18	54, 243, 648	2
1892	2, 172, 953, 088	811. 28	412, 043, 328	158. 96	177, 525, 216	6
1893	1, 170, 097, 056	436. 86	307, 895, 040	118. 78	.....	.....
Total, 7¾ years	7, 338, 379, 680	.....	2, 369, 108, 736	.....	1, 104, 908, 256	.....
Mean	917, 297, 460	342. 48	296, 138, 592	114. 25	138, 113, 532	5

Year.	Total amount for year.	Avera dischar per sec
	Cubic feet.	*Cubic f*
1886	4, 774, 382, 265	20
1887	5, 071, 323, 168	16
1888	6, 126, 296, 976	19
1889	6, 209, 373, 600	19
1890	4, 501, 144, 512	14
1891	4, 631, 240, 448	14
1892	6, 309, 689, 184	19
1893	6, 084, 319, 104	19
Total, 7¾ years	43, 707, 769, 257	.....
Mean	5, 639, 712, 162	1

Area of watershed of Pine River Reservoir, 562.07 square miles = 15,669,612,288 square feet.
Mean annual rainfall from May 1, 1887, to December 31, 1893, 22.981 inches.
Total rainfall on this basis from Apr. 1, 1886, to Dec. 31, 1893, 236,642,484,773 cubic feet.
Amount liberated from Pine River Dam from Apr. 1, 1886, to Dec. 31, 1893, 43,707,769,257 cubic
Percentage of rainfall liberated from Pine River Dam from Apr. 1, 1886, to Dec. 31, 1893, 18,47

RELATION BETWEEN RAINFALL AND RESERVOIR DISCHARGE.

The following data has been collected from the observations made at ıe reservoir stations since their completion:

In the fall of 1884 the three upper dams, Leech Lake, Lake Winnibigoshish, and Pokegama Falls Dam were completed, and since January ,1885, complete records of rainfall and discharge were kept at each of hose dams. Pine River Dam was completed in the fall of 1886, but ecords of the discharge were kept from April 1 of that year. The ecords of rainfall, however, were not kept until May 1, 1887.

Tables I, II, III, and IV summarize the observations. Table I shows he rainfall at Leech Lake, Lake Winnibigoshish, and Pokegama Falls lams for each year and month, the total and mean annual rainfall dur- ng the years 1885 to 1893, inclusive. Table II shows the average and otal discharge for each month and year, as well as the total and mean nnual discharge, at Pokegama Falls Dam during the years 1885 to 1893, inclusive. Table III shows the rainfall at Pine River Dam for ach year and month, the total and mean annual rainfall from May 1, 1887, to December 31, 1893. Table IV shows the average and total lischarge for each year and month, as well as the total and mean nnual discharge at Pine River Dam, from April 1, 1886, to December 31, 1893.

The watershed above Pokegama Falls is 3,265.46 square miles, equal o 91,035,800,064 square feet. The mean annual rainfall for the Leech Lake, Lake Winnibigoshish, and Pokegama Falls reservoirs from our present data is 24.737 inches. The total rainfall from 1885 to 1893, nclusive, is a depth of 18.5536 feet or 1,689,041,820,067 cubic feet.

The excess in the reservoirs above Pokegama Falls Dam on Decem- ber 31, 1893, over the amount on hand on December 31, 1884, was 1,587,716,698 cubic feet. The total amount liberated from the Pokegama Falls Dam during the years 1885 to 1893, inclusive, was 82,648,990,528 cubic feet. Assuming that the surplus, 1,587,716,698 ubic feet, will pass through the Pokegama Falls Dam, the total available rom the rainfall will be 284,238,435,226 cubic feet. The percentage of he rainfall which finds its way into the Mississippi at Pokegama Falls s therefore 16.828. The mean annual discharge being 995.26 cubic feet er second, and the area of the watershed being 3,265.46 square miles, re have a discharge of 0.305 of a cubic foot per second from each square nile of watershed.

The mean annual rainfall at Pine River Dam is 22.981 inches, and the rea of the watershed is 562.07 square miles=15,669,612,288 square eet. The total rainfall from April 1, 1886, to December 31, 1893, is 36,642,484,773 cubic feet. The amount liberated from Pine River Dam rom April 1, 1886, to December 31, 1893, was 43,707,769,257 cubic feet. he percentage of the rainfall which passes through Pine River Dam therefore 18,470.

The average discharge per second from Pine River Dam is 178.63 ubic feet; and the watershed being 562.07 square miles, the discharge r second for each square mile of watershed is 0.318 of a cubic foot r second.

In regard to the release of water from the Pokegama Falls Dam, the lowing discharge during each year will probably give the most satis- tory results during each year:

Discharge per second in—	Cubic fee
January	30
February	30
March	10
April	*50
May	90
June	90
July	95
August	2,25
September	2,25
October	2,25
November	†94
December	3

For the discharge at Pine River Dam the following arrangemer will probably cover the case to the best advantage:

Discharge per second in—	Cubic fe
January	
February	
May	1
June	2
July	3
August	4
September	4
October	4
November	
December	

During the low-water season, August, September, and October, have 2,250 cubic feet per second from the Pokegama Falls Dam, a 450 cubic feet per second from the Pine River Dam, which makes total of 2,700 cubic feet per second from the four reservoirs now und control.

Amount expended during fiscal year ending June 30, 1894, includi outstanding liabilities, $43,294.

The beneficial effects resulting in previous years from the operat of the completed reservoirs have been maintained.

During the season of 1893 the water collected and released was:

The total supply for the year from the principal collecting reservoi Leech Lake and Lake Winnibigoshish, was 25,952,075,648 cubic feet 9,827,350,272 cubic feet and 16,124,725,376 cubic feet, respectively.

The greatest height reached by the retained water in Leech Lal was 1.85 feet, June 3 to 24, and in Lake Winnibigoshish, 8.86 feet, Jul 29, indicating, approximately, an accumulation of 10,000,000,000 cubi feet in the former and 30,000,000,000 cubic feet in the latter.

Leech Lake Reservoir.—With the exception of a small discharge i January 1 to 24 the water released from Leech Lake up to June 7 wa leakage only. Beginning June 7 the discharge was increased to a average of 598.31 cubic feet per second for the remainder of the montl making a total discharge for June of 1,323,200,448 cubic feet; maximu discharge, June 24, 912.33 cubic feet per second; minimum discharg June 4, 51 cubic feet per second.

Average discharge in July, 729.95 cubic feet per second; maximun 893.51 cubic feet per second, July 1; minimum, 642 cubic feet per second July 14; total for month, 1,955,093,760 cubic feet.

Average discharge in August, 660.14 cubic feet per second; maximun

* This may be 100 cubic feet per second from April 1 to 15, and 900 cubic feet pe second from April 15 to 30.

† This may be 1,586 cubic feet per second from November 1 to 15, and 300 cubi feet per second from November 15 to 30

742.96 cubic feet per second, August 10; minimum, 623.21 cubic feet per second, August 31; total for the month, 1,768,115,520 cubic feet.

Average discharge in September, 550.25 cubic feet per second; maximum, 623.21 cubic feet per second, September 1; minimum, 470.22 cubic feet per second, September 30; total for the month, 1,426,258,368 cubic feet.

Average discharge in October, 406.18 cubic feet per second; maximum, 531.97 cubic feet per second, October 5; minimum, 175 cubic feet per second, October 25; total for the month, 1,061,998,560 cubic feet.

The dam was closed October 20, the discharge after that date, with the exception only of a small output on the 25th, being leakage through the stop plank. The discharge for the last eleven days of October, leakage mainly, was 197.94 cubic feet per second.

Average discharge in November, 173.06 cubic feet per second; maximum, 195.42 cubic feet per second, November 1; minimum, 138.38 cubic feet per second, November 30; total for the month, 448,561,152 cubic feet.

Average discharge in December, 125.60 cubic feet per second; maximum, 131.97 cubic feet per second, December 1; minimum, 120.50 cubic feet per second, December 30; total for the month, 336,350,272 cubic feet. All of the discharge in November and December was in leakage.

The water levels in Leech Lake Reservoir, above the low-water stage, as affected by the supply and discharge in 1893, were as follows:

	Feet.
January 7	0.32
February 4	.35
March 4	.49
April 1	.66
May 6	1.34
June 3	1.85
July 1	1.79
August 4	1.36
September 2	1.08
October 2	.69
November 4	.47
December 2	.55
December 30	.64

At the close of the year the lake level showed a gain of 0.32 foot, indicating, approximately, that the supply from the watershed had exceeded the discharge to the extent of about 1,500,000,000 cubic feet.

Winnibigoshish Reservoir.—The first release of water from Winnibigoshish Reservoir was made between January 22 and February 17, during which period there was an average discharge of 309.11 cubic feet per second; 301.28 cubic feet per second for the ten days in January, and 317.46 for the seventeen days in February; a total discharge in January of 254,800,288 cubic feet, and in February of 446,286,976 cubic feet.

On February 18 the dam was closed, remaining so until July 30. During the closed periods, between January 1 and July 30, one hundred and eighty-two days, there must have been a flow of leakage, averaging, probably, 50 cubic feet per second; of this flow from leakage, however, no record was kept at the dam.

Beginning July 30, the regular release of water was commenced.

Average discharge in July, two days, 304.84 cubic feet per second; total for the month, 52,663,392 cubic feet.

Average discharge in August, 1,780.73 cubic feet per second; maximum, 2,480.67 cubic feet per second, August 27; minimum, 300.72 cubic feet per second, August 5; total for the month, 4,778,158,464 cubic feet.

Average discharge in September, 2,548.46 cubic feet per second; maximum, 2,839.89 cubic feet per second, September 25; minimum, 2,360.58 cubic feet per second, September 10; total for the month, 6,605,608,320 cubic feet.

Average discharge in October, 2,354.01 cubic feet per second; maximum, 2,644.05 cubic feet per second, October 3; minimum, 1,810 cubic feet per second, October 17–19; total for the month, 3,864,338,496 cubic feet. The dam was closed October 19, remaining so until the end of the year, except the last five days of December, when an average discharge of 220 cubic feet per second was made; total discharge in December, 122,869,440 cubic feet.

Total number of days discharge was made, 116; during the 249 days the dam was closed it is estimated that there must have been an average flow from leakage of, probably, 50 cubic feet per second.

The water levels in Lake Winnibigoshish Reservoir, above the low-water stage, as affected by the supply and discharge in 1893, were as follows:

	Feet.
January 1	5.47
February 1	5.62
March 1	5.71
April 1	6.05
May 1	6.64
June 1	7.80
July 1	8.43
August 1	8.86
September 1	8.20
October 1	5.62
October 17	4.27
November 1	4.23
December 1	4.31
December 26	4.36

The elevations as above show a loss of water level in the lake of 1.11 feet during the year, indicating a draft on the water left in the reservoir from the preceding year of about 3,500,000,000 cubic feet.

There was nothing worthy of special notice in connection with the discharge of water from the Leech Lake and Lake Winnibigoshish reservoirs, except the fact that the discharge was interfered with at the dam of the latter reservoir by floating bog, which at times partially or completely closed some of the sluices, thereby suddenly reducing the discharge and complicating the calculations as to the quantity of water released. The floating bog comes entirely from the shores of Winibigoshish Bay, where it has been loosened from its bed by successive high-water stages, and when the wind happens to be favorable it is carried to the dam.

The construction of a sheer boom, it is believed, would prevent a recurrence of this interference.

The output from Leech Lake and Lake Winnibigoshish reservoirs, together with the supply from the watershed below them, gave supply for the following discharge from Pokegama Reservoir:

Pokegama Reservoir.—As the distributing reservoir for the Upper Mississippi River system, the release of water from Pokegama Reservoir is practically continuous, varying according to the season and the necessities of the river below; during the season of 1893 the dam was only closed for three days, and then only for necessary repairs.

Average discharge in January, 328.54 cubic feet per second; maximum, 500.98 cubic feet per second, January 21; minimum, 207.97 cubic feet per second, January 1; total for the month, 879,966,720 cubic feet.

.verage discharge in February, 403.40 cubic feet per second; maxi-
m, 475.15 cubic feet per second, February 1; minimum, 146.30 cubic
; per second, February 20; total for the month, 803,975,328 cubic
.

Average discharge for March, 150.80 cubic feet per second; maxi-
m, 153.49 cubic feet per second, March 31; minimum, 148.04 cubic
t per second, March 1; total for the month, 403,901,856 cubic feet.
Average discharge in April (twenty-seven days), 153.67 cubic feet per
ond; maximum, 160.97 cubic feet per second, April 23; minimum,
.90 cubic feet per second, April 24; total for the month, 358,482,240
ic feet. April 15–17. the dam was closed for repairs at the foot of
log sluice.
Average discharge in May, 315.20 cubic feet per second; maximum,
26 cubic feet per second, May 23; minimum, 145.78 cubic feet per
ond, May 1; total for the month, 844,242,048 cubic feet.
Average discharge in June, 611.76 cubic feet per second; maximum,
79.93 cubic feet per second, June 4; minimum, 145.80 cubic feet per
ond, June 8; total for the month, 1,585,690,560 cubic feet.
Average discharge in July, 973.69 cubic feet per second; maximum,
05.68 cubic feet per second, July 2; minimum, 574.60 cubic feet per
ond, July 14; total for the month, 2,607,990,048 cubic feet.
Average discharge in August 1,449.27 cubic feet per second; maxi-
m, 2,827.26 cubic feet per second, August 22; minimum, 468.75
ic feet per second, August 10; total for the month, 3,882,079,872
ic feet.
Average discharge in September, 2,742.11 cubic feet per second;
ximum, 2,958.72 cubic feet per second, September 8; minimum,
08.89 cubic feet per second. September 1; total for the month,
07,537,888 cubic feet.
Average discharge in October, 2,789.10 cubic feet per second; maxi-
n, 2,961.92 cubic feet per second, October 7; minimum, 2,456.43
ic feet per second, October 31: total for the month, 7,512,146,496
ic feet.
Average discharge in November, 1,091.00 cubic feet per second;
ximum, 2,353.51 cubic feet per second, November 1; minimum,
cubic feet per second, November 25; total for the month,
8,491,448 cubic feet.
Average discharge in December, 412.66 cubic feet per second; maxi-
m, 499.12 cubic feet per second, December 8; minimum, 301.80 cubic
; per second, December 6; total for the month, 1,105,271,136 cubic
.

Total discharge for the year at Pokegama Falls Dam, 29,919,775,680
ic feet, equal to an average daily discharge of 948.88 cubic feet per
ond; maximum discharge, 2,961.92 cubic feet per second, October
minimum discharge, 141.90 cubic feet per second, April 24.
The discharge from Pokegama Reservoir for the entire year was
67,703,032 cubic feet in excess of the quantity of water released from
ch Lake and Lake Winibigoshish reservoirs; which quantity, less
leakage from Winibigoshish Reservoir, represents the supply
m Pokegama watershed. To the supply from Pokegama watershed,
gured on this basis, should, however, be added the loss from evapo-
ion and infiltration during the period of large discharge from the
er dams, August, September, and October, which. as the flooded
a is very large, must be a considerable quantity.
The main interest in the discharge of 1893 was centered in the release
ater during the months of August, September, October, and Novem-
, for the benefit of navigation on the river below St. Paul.

the outlet of Leech River and Pokegama, as in previous large dis
In this case the height reached by the water in Ball Club Lake
feet above the low-water stage. This height backed the water
the small lake above Ball Club Lake to the height of 3 feet, a
flowed all the low country adjacent to the river as far down as
let of Vermillion River; covered the swamps and meadows
River, coming within 13 inches of grade on one of the bridge
Duluth and Winnipeg Railroad crossing Deer River. The mea
the vicinity of White Oak Point were covered from 3 to 5 feet.

By the piling up of the water at the outlet of Leech River, M
was raised 5 feet, and the effect of the race water was noticeabl
river 10 miles or more above Mud Lake.

This accumulation and spreading of water over a great area of
above Vermillion River is unavoidable with discharges from t
dams exceeding 2,000 cubic feet per second, as sufficient head
formed above the outlet of Vermillion River to force the water
that narrow river valley, from that point to White Oak, Lake
a distance of about 8 miles by water.

With a discharge of 2,000 cubic feet per second it is estimated
river section is sufficiently large to carry the water without flo
low lands to any material extent.

Though the water this year, between the upper dams and Pol
was not quite as high as that of some previous discharges, as indi
the Ball Club Lake gauge, complaints of damage from high wa
more numerous; mainly, probably, because the country in that
has been extensively settled upon in the years since the last la
let of water. Much of the land now occupied has, however, be
chased or otherwise obtained subject to flowage, though in so
it has been claimed that lands have been overflowed that had
included within the flowage lines as originally determined.

The large release of water from Pokegama Reservoir wa
August 20, with a discharge of 2,598.31 cubic feet per second.
time the gauge in Pokegama Lake indicated a stage of 5.44 fe
low water, and the valley above Pokegama was well filled by

November (1–15) average, 1,625.41 cubic feet per second; total for that portion of the month, 2,106,531,360 cubic feet.

Total discharge from Pokegama Reservoir between August 20 and November 15, 19,446,495,552 cubic feet. a daily average of 2,543.55 cubic feet per second.

The water released from Leech Lake and Lake Winnibigoshish Reservoirs as a supply for the discharge from Pokegama Reservoir was 19,339,101,216 cubic feet, 107,394,339 cubic feet less than the quantity discharged from Pokegama Reservoir; as, however, during this time of large discharge there should have been an increment to the water supply in Pokegama from rainfall of 981,804,658 cubic feet, there was really no excess; on the contrary, with the supply from rainfall as above, a loss of over 800,000,000 cubic feet would be indicated, which loss would be attributable to evaporation and infiltration on the flooded area above Pokegama.

The year's supply from Pokegama watershed, figured on the basis of 16.746 per cent of the rainfall, as arrived at from the rainfall and total discharge on the entire system, for the season of 1893, should have been 6,025,372,650 cubic feet.

This quantity, added to the total discharge from the upper reservoirs, would give 31,977,448,298 cubic feet, which, as the total discharge for the entire year from Pokegama was 29,919,775,680 cubic feet, would indicate a loss between the upper dams and Pokegama of about 2,000,000,000 cubic feet, presuming that there was about the same quantity of water at the end of the year in Pokegama Reservoir as there was at the beginning, though, in fact, Pokegama Lake was about 1.3 feet lower at the close of 1893.

The large release of water from Pokegama Dam was unattended by incident of interest other than that of the passage through the dam of a large quantity of saw logs, in the vicinity of 35,000,000 feet, B. M., during the first thirteen days of the discharge. The logs began to arrive at the dam several days before the discharge was commenced in August, and the river was practically full of logs for 15 miles or more above the dam. The presence of the logs in the river was found to materially obstruct the flow of water, so that it was necessary that they should be got rid of as quickly as possible.

The movement of the logs and the working of the driving crews in the swampy country in the vicinity of the outlet of Pokegama Lake dislodged large areas of floating bog, which came to the dam and was sluiced with the logs. It is estimated that at the very least 100 acres of this bog was passed through the log sluice. The bog came to the dam frequently in large sheets, 3 to 4 feet thick, and of an acre or more in area, so that it was necessary to saw it up into sections of such size as could be passed through the log sluice.

With reference to the passage of logs through the dam during a large flow of water, it was found that from 2,600 cubic feet to 2,800 cubic feet per second was practically the limit, as with the present arrangement of sheer booms above the dam a larger discharge made the current so strong as to cause the logs and bog to pass under the boom, and so clog the small discharge sluices as to render the closing of the entire dam necessary to clear them.

Even with the discharge of 2,600 cubic feet per second, the set of the current at right angles to the direction of the main sheer boom was so great as to cause much delay and trouble in closing off the water and clearing the sluices of both logs and bog.

During the large discharge from Pokegama Reservoir there was a considerable increment to the river from Pine River Reservoir—in August (20 to 31), 389.55 cubic feet per second; in September, 785.05 cubic feet per second; in October, 436.86 cubic feet per second, and in November (1 to 15), 227.63 cubic feet per second; in all, 3,903,635,808 cubic feet; making, with the flow from Pokegama, a total from the reservoirs of 23,350,129,360 cubic feet—an average daily discharge for the 88 days of flow of 3,071.09 cubic feet per second.

The Board of Engineers in their report dated May 24, 1887, and printed on pp. 1681–1698 Annual Report of the Chief of Engineers, 1887, express this opinion:

As far down as the mouth of the first considerable tributary, the St. Croix, it is therefore not unreasonable to suppose that navigation may be benefited nearly in proportion to the effect upon the St. Paul gauge, i. e., from 1 foot to 18 inches of low-water stages.

My predecessor, in his annual reports for the years 1887, 1888, and 1889, has stated:

From such observations as means admitted of in 1885 and 1886, and stated in my reports of December 18, 1885, and November 5, 1886, both of which are here respectfully referred to, it appeared that when the river stood at 2 feet on the U. S. Signal Service gauge at St. Paul, the effect of every 100 cubic feet per second of water added to the river and steadily maintained was equivalent to increasing the depth one-tenth of a foot. As the river rises the depth effect of each 100 cubic feet of water decreases somewhat. It appears, however, from examinations in 1885 and 1886, that the effect of the liberated water from the four reservoirs was the addition of 1 foot and upward to the depth at St. Paul during the dry periods of those years, the additional depth being due to elevation of water service as well as to additional scour. (See Appendix A A, Annual Report, 1887.)

The benefit of the reservoir volume extended over some 425 [390] miles of river below Grand Rapids, the rapids being 388 [353] miles by river above St. Paul. Of the 425 [390] miles, 200 [165] are navigated by steamers.

The increase in channel depth at St. Paul due to the release of the stored-up water undoubtedly averaged, for the eighty-six days, 1 foot to 1½ feet. (See Appendix Z, Annual Report, 1888.)

The increase in channel depth at St. Paul due to the reservoir water undoubtedly averaged 1 foot during the low-water season of 1888. (See Appendix B B, Annual Report, 1889.)

The effect of the reservoirs on the navigable depth of water in the channel of the Mississippi River above the Falls of St. Anthony is not as conclusively shown as it could be. A series of hydrological and meteorological observations on the Mississippi and the principal tributaries above St. Paul, extending over a period of several years, would furnish information not only of great practical value in the operations of the reservoirs, but would also be of scientific value in connection with the loss of river water by evaporation and filtration and in the progression (and even dispersion) of a flood wave. A commencement in this direction has been made by the provision for gaugings at or near St. Paul, but the money available for the purpose is inadequate for thorough work, and is only applicable near St. Paul. It is estimated that the sum of $15,000 per annum can be profitably expended in hydrological and meteorological investigation during a period of four years.

These dams have been created for impounding enormous bodies of water and releasing the same under control. The water is released through sluices, which are opened or closed by operating devices. The operating portion of each is made of wood. This wood is subject to decay, and from this time on extensive repairs are likely to be called for at any time. It is impossible to foresee the full extent of such repairs in time to make an estimate for funds in the next succeeding annual report and thereafter await the chances of an appropriation during

nore years. Grave liability would arise for losing the dams, attendant loss of life and property below them. It is there- ›mmended that the reservoir system be placed under the opera- he statute which provides a permanent appropriation for the :ration, and maintenance of completed structures which bene- erce and navigation.

›nstruction purposes the sum of $130,000 can be profitably d during the two years ending June 30, 1897, as follows:

n of navigable pass in Sandy Lake Dam	$13,333
ion of Gull Lake Reservoir and Dam	86,667
cal and meteorological investigations, two years, at $15,000 per year	30,000
ıl	130,000

mmerce benefited by the reservoirs, reference must be made to nercial statistics of the Mississippi River.

luable assistance in work upon and management of the reser- am greatly indebted to Mr. Archibald Johnson, assistant

Abstract of appropriations.

ved June 14, 1880	$75,000.00
ved March 3, 1881	150,000.00
l August 2, 1882	300,000.00
ved July 5, 1884	60,000.00
ved August 5, 1886	37,500.00
gust 11, 1888	12,000.00
ved September 19, 1890	90,000.00
ved July 13, 1892	60,000.00
ıl	774,500.00
per letter from office Chief of Engineers—	
ıber 9, 1881	1,572.15
ry 20, 1882	176.00
ry 18, 1888	643.85
1, 1888	8.60
of commissioners in attempted settlement of awards to	333.73
nd expended by officer in charge for meteorological observa- rings, examinations, etc., at proposed dam sites—letter from ief of Engineers, May 27, 1881	7,500.00
by the officer in charge in connection with the building rating of five reservoir dams to June 30, 1894, including ling liabilities	760,859.34
ıl allotted and expended to June 30, 1894, including out- anding liabilities	771,093.67
cost of the system (omitting that of land, etc., damages)	1,809,083.50
ppropriated	774,500.00
aining to be appropriated	1,034,583.50

Money statement.

3, balance unexpended	$55,550.17
394, amount expended during fiscal year	50,277.59
4, balance unexpended	5,272.58
4, outstanding liabilities	1,866.25
4, balance available	3,406.33
(estimated) required for completion of existing project	1,034,683.50
that can be profitably expended in fiscal year ending June 6	115,000.00

ed in compliance with requirements of sections 2 of river and acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Z 3.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 56 miles, to confine the low-water volume to a channel of nearly uniform width and depth. The general plan for improvement was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less as to location and extent of dams, jetties, etc.

The object of the protection of the Yellow Banks is to prevent erosion of the high sand bluffs or banks bordering the Chippewa River at a number of points below Eau Claire, and thereby to relieve the channels of that river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks. The plan for protection consists in a revetment of piling and fascines, the latter to be crowned with rock.

The examinations of this river upon which the plan and estimates were based were made in 1874 and 1875. The two reports dated January 30, 1875, and December 13, 1875, were printed on pp. 373-380, Part I, Annual Report for 1875, and pp. 707-709, Part I, Annual Report for 1876, respectively. In those reports the estimate of the cost of improvement below Eau Claire was: For channel improvements, $75,790; for protecting Yellow Banks, $64,102.50; total, $139,892.50.

The first appropriation for improving the Chippewa River was made in 1876, and the first that was applied to the protection of the Yellow Banks was made in 1882. These were regarded as separate and distinct works until the act of Congress of August 11, 1888, appropriated for the improvement of the Chippewa River, including the Yellow Banks in said river, Wisconsin, continuing improvement, $10,000.

The estimated cost, including all expenditure since 1876, for channel improvement of the river, as revised by my predecessor in 1888 (see pp. 1543, 1544, Annual Report for 1888), was placed at $176,487.72. The cost of protecting the Yellow Banks, as revised by the same officer in 1883 (see p. 1443, Annual Report for 1883), was estimated at $96,000, making the total cost for channel improvement and the protection of the Yellow Banks $272,487.72.

Before the improvement commenced the depth on the bars at low water seldom exceeded 18 inches, and the crossing at the mouth of the river was extremely difficult at that stage, owing to the volume of the river joining the Mississippi through a number of channels of insufficient depth. Frequently the depth of water on the bar at the mouth of the river was but 10 or 12 inches.

The work of improvement to June 30, 1893, has provided a permanent channel 3 feet in depth over the bar at the mouth of the river, and materially increased the depths over the Durand, Plum Island, Plum Island Flats, Battle Island, Wacouta Island, and Flower Pot Island bars, besides straightening a difficult piece of river at the Madison street bridge in Eau Claire, and the stoppage of a difficult, dangerous cut-off at Dead Lake. Where the improvements have been completed the channels are 3 feet or more in depth. The channel improvements have effected a material reduction in the cost of running rafted lumber from Eau Claire to the mouth of the river.

No work of consequence has been done at the Yellow Banks since 1883.

At that time revetments of the banks had been accomplished as follows:

At Waubeek Bank, 2,989 feet long, protection completed.

At Rumseys Bank, 4,500 feet long, piles all driven and 1,850 linear feet of protection completed.

At Mary Dean Bank, 6,900 feet long, piles have been driven for 625 linear feet, and 139 feet of the protection completed.

Total expended from commencement of operation in 1877 to June 30, 1893, including outstanding liabilities, $171,022.76.

Operations during the past fiscal year.—On account of the small amount of funds available, work during the past year was confined to completing the repairs to Eau Galle Flats Dam No. 1. This dam was built on the ice during the winter of 1892–'93. It was injured by the ice jams of the following spring, as detailed in my last annual report. The repairs were at once commenced and completed in August, 1893. The effect of the dam on the channel of the river has been very beneficial. The Eau Galle Flats have for several years past been the shoalest place on the river, and occasioned the greatest trouble to the passage of rafts. It was not expected that the one dam would effect a complete and permanent improvement, but it did result in such a betterment that during the past season rafts were floated over the flats without difficulty.

In this connection I desire to state that the appropriations for this improvement since 1883 have been inadequate to maintain existing dams in good condition, and at the same time relieve navigation interests by the construction of new works on bars that are serious obstructions to the passage of rafts. A connected survey of the river is needed, particularly of the lower 20 miles from Waubeek Valley Bank to the mouth. The necessity for this survey has been repeatedly urged by my predecessors. In order to obtain the best effect from works of improvement, they should be located as parts of a systematic plan. This can only be done by aid of a complete survey.

The following statement shows the cost of work during the past year:

Care of property, superintendence, and St. Paul office expense		$188.71
Eau Galle Flats Dam No. 1:		
45.4 cords brush, at $1.75	$78.95	
9.75 cords stone, at $6.50	63.37	
Delivery by flatboat and placing 107.4 cords brush and 58.35 cords stone	396.21	
		538.53
Total expense for year		727.24

Distribution of materials on hand June 30, 1893.

Eau Galle Flats Dam No. 1:	
15 cords of stone, at $6.50	97.50
33½ cords of stone, at $5.25	175.87
62 cords of brush, at $1.75	108.50
	381.87

Statement of materials on hand June 30, 1894.

Hum Island:	
81½ cords brush, at $1.72	140.51
53½ cords stone, at $5	205.62
	346.13

Dams, jetties, revetments, and Yellow Banks protections constructed and kept in repair, 1877 (when work was begun) to fiscal year ending June 30, 1894.

Description.	Locality.	Constructed during fiscal year.	Yellow Banks protection.	Channel improvement.
			Lin. feet.	*Lin. feet.*
East jetty (2,110 linear feet)	Mouth of river	1878-'79	}	6,123
West jetty (4,013 linear feet)	do	1878	}	
Shore protections	do	1888		654
Dam	Little Missouri Chute	1880		300
Dam	Flower Pot Bar	1880-'81-'82		2,065
Shore protection, 1,335 feet, since washed away.	Three Mile Prairie	1883		
Dam No. 1	Dark Slough	1882		225
Dam No. 2	do	1889		319
Dam	Wacouta Island	1883		325
Dam No. 1	Five Mile Bluff	1887		1,000
Dam No. 2, shore connection only	do	1887		75
Dam	Battle Island	1882		820
Dam No. 1	Plum Island Flats	1889		1,305
Dam No. 2	do	1892		1,000
Dam No. 3	do	1892		500
Dam	Jack Staff Island	1882		275
Dam	Plum Island	1882		400
Dam	Dead Lake Cut-off	1883		325
Dam No. 1	Eau Galle Flats	1893		750
Dam No. 1 (lower)	Durand	1884		600
Dam No. 2 (upper)	do	1884		600
Dam	Eau Claire	1887		810
Protection, Yellow Banks	Waubeek	1883-'84	2,989	
Protection, Yellow Banks	Rumsey	1883-'84	1,850	
Protection, Yellow Banks	Meridian	1883-'84	139	
Total			4,978	18,471

Mr. A. O. Powell, assistant engineer on this improvement, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

Expenses during the fiscal year ending June 30, 1894, including outstanding liabilities, $727.24.

The sum of $70,000 can be profitably expended during the fiscal year ending June 30, 1896.

For channel improvements	$60,000
For survey	10,000
Total	70,000

This work is in the collection district of Milwaukee, Wis. The duties on imports collected during the year ending December 31, 1893, amounted to $475,749.67.

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Approved August 5, 1886	$18,750
Approved June 8, 1878	10,000	Of August 11, 1886	10,000
Approved March 3, 1879	8,000	Approved September 19, 1890	10,000
Approved June 14, 1880	10,000	Approved July 13, 1892	5,000
Approved March 3, 1881	10,000	Total	171,750
Passed August 2, 1882	65,000		
Approved July 5, 1884	15,000		

Money statement.

July 1, 1893, balance unexpended	$1,125.56
June 30, 1894, amount expended during fiscal year	1,075.82
July 1, 1894, balance unexpended	49.74
July 1, 1894, outstanding liabilities	49.74
Amount (estimated) required for completion of existing project	100,737.72
Amount that can be profitably expended in fiscal year ending June 30, 1896	60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

omparative statement of lumber, laths, shingles, pickets, and logs for sixteen years.

Year.	Lumber.	Laths.	Shingles.	Pickets.	Total tonnage, exclusive of loose logs.	Loose logs.
	Feet, B. M.	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet, B. M.*
.....	154, 119, 860	40, 000, 000	125, 000, 000	10, 000, 000	.....	Unknown.
).....	248, 932, 000	62, 044, 000	135, 152, 000	12, 000, 000	.....	250, 000, 000
).....	325, 150, 000	100, 357, 750	74, 945, 150	2, 423, 940	.....	300, 000, 000
.....	342, 887, 000	64, 787, 000	121, 437, 000	1, 880, 000	.....	300, 000, 000
.....	375, 000, 000	66, 000, 000	150, 000, 000	2, 200, 000	.....	350, 000, 000
.....	269, 094, 203	82, 643, 500	129, 754, 000	1, 497. 948	.....	450, 000, 000
.....	298, 344, 591	88, 905, 520	160, 133, 000	1, 840, 278	.....	534, 674, 176
5.....	374, 138, 443	95, 992, 900	195, 880, 220	75, 000, 000	.....	600, 000, 060
6.....	207, 205, 672	77, 729, 630	158, 645, 750	1, 934, 340	.....	465, 000, 000
7.....	186, 826, 521	64, 725, 580	130, 516, 200	3, 023, 235	.....	404, 302, 650
8.....	161, 309, 512	50, 544, 370	86, 348, 900	1, 500, 320	325, 971	542, 437, 000
9.....	158, 938, 294	50, 487, 355	112, 053, 075	2, 244, 786	329, 156	400, 518, 720
0.....	166, 477, 966	46, 234, 673	78, 499, 500	1, 222, 989	342, 350	606, 992, 790
1.....	152, 040, 386	107, 841, 850	48, 700, 210	1, 258, 850	314, 085	284, 113, 430
2.....	144, 651, 150	46, 541, 170	109, 856, 000	1, 507, 050	410. 960	632, 350, 670
3.....	159, 180, 534	43, 938, 210	108, 774, 500	1, 940, 525	459, 505	488, 926, 000

Comparative statement of freight and passengers for sixteen years.

Year.	Steamboats.	Freight carried.	Passengers.	Year.	Steamboats.	Freight carried.	Passengers.
		Pounds.				*Pounds.*	
878.....	4	Unknown.	Unknown.	1886.....	1	.....	4, 700
879.....	4	6, 840, 000	8, 730	1887.....	1	600, 000	1, 400
880.....	4	3, 440, 000	11, 240	1888.....	*1	.....	.....
881.....	3	3, 932, 000	16, 989	1889.....	*1	.....	.....
882.....	3	2, 640, 000	10, 490	1890.....	*1	.....	.....
883.....	3	3, 184, 000	4, 000	1891.....	*1	.....	.....
884.....	2	1, 500, 000	5, 500	1892.....	*1	.....	.....
885.....	1	690, 000	4, 728	1893.....	*1	.....	.....

* One hundred and eight tons burden and 2 feet draft.

But one steamboat plied regularly on the river during the past five seasons. This boat, the *Phil Sheckel* (108 tons burden and 2 feet draft), ran from the mouth to Dunnville, about half-way between the mouth and Eau Claire to assist the Knapp–Stout & Co. Company's rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

Z 4.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The project and original estimate for the improvement of this river were submitted by Maj. Farquhar in a report dated January 30, 1875 (pp. 373–375, Part I, Annual Report, 1875), upon the results of a survey made in 1874 when the St. Croix was at a high stage of water, and but comparatively few bars or other obstructions to be seen, and contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand bars between Taylor Falls and Prescott, and contraction of low-water channel between Taylor Falls and Stillwater into one of nearly uniform width, by means of brush and stone jetties and dams of the same material, to close island chutes and secondary channels. Estimated cost, $21,758.

In 1879 Maj. Allen made a low-water survey of the river, submitting his report January 26, 1880. In this report, printed on pp. 1661-1668, part 2, Annual Report, 1880, he estimated the cost to complete improvements at $60,250, making a total of $78,250 from time of commencement in 1878.

The estimate was revised in 1882 and again in 1889. (See p. 1801, Annual Report, 1889.) The last revision placed the cost at $34,200 to complete, or a total of $129,700 for the whole improvement.

The lower part of the river is known as Lake St. Croix. Stillwater, at the head of the lake, divides the navigable portion of the river into two sections: The upper or river section, 28½ miles in length, and the lower or lake section, 23.8 miles in length.

In the Annual Report of 1889 my predecessor reported:

> The first appropriation for the improvement of the St. Croix was $10,000, made by act of Congress approved June 18, 1878.
>
> At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom piers, and the bends by leaning trees. The low-water channel had in many places but 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions. At times it was impossible for them to get over the shoal places. Under this appropriation some of the worst obstructions were removed between Taylor Falls and Stillwater.

The free navigation of the lower section was obstructed by partly-sunken logs and by the Hudson and Catfish bars, 6.3 and 15.1 miles, respectively, below Stillwater. The channel over the Hudson Bar was quite tortuous and shallow, having but 2½ feet depth at low water. At Catfish the channel had sufficient depth, but made a sharp bend around a long, narrow sand spit that jutted out for a distance of 1,450 feet from the left bank and at right angles to the shore line. When a strong wind blew up or down the lake, the steamboat with heavy rafts encountered considerable difficulty in keeping the channel.

The improvements to June 30, 1891, resulted in a decidedly improved channel above Stillwater to the advantage of the river traffic then existing. The improvements consisted in the removal of sunken cribs, wrecks, snags, old boom piers, and leaning trees, and the construction of wing dams to contract the channel over the worst bars, and thereby increased the depth over the bars worked on from an original low-water depth of 2 to 3 feet.

Since 1886, the railroads penetrating the region have reduced navigation over this section to almost nothing, except the running of loose logs; as a consequence, little attention during the past six years has been given to its improvement.

On the lower section (Stillwater to the mouth) the commerce, consisting of rafted lumber and logs towed by steamboats, is of large proportions and its needs are being met by expending the largest part of appropriations on this reach. By June 30, 1893, channels had been dredged through the Catfish and Hudson bars to a depth of 4 feet at low water, and the water directed into new channels by training dams.

Many of the partly-submerged logs were also removed, but new ones are continually coming into the channel. The work had resulted in creating a fair steamboat channel, 4 feet deep at low water, from Stillwater to the mouth. Boats and rafts can now pass over that distance at the lowest stage, but some work remains to be done in widening the dredged channels and straightening other portions, particularly on the Hudson Bar above and below the bridge.

Expended to June 30, 1893, including outstanding liabilities, $106,012.21.

ations during the past fiscal year: Work was confined to dredg-
the channel over the Hudson Bar. Total amount of excavation
cubic yards. The work at Hudson Bar has facilitated the pas-
raft boats with their large tows.
l expended during the fiscal year ending June 30, 1894, includ-
standing liabilities, $2,487.79.

Total of work done since the commencement of operations in 1878.

moved	number..	4,091
trees removed	do....	6,344
removed	do....	2,722
moved	do....	32
piers removed	do....	44
removed	do....	3
moved	do....	718
d gravel removed above Stillwater	cubic yards..	146
s removed	do....	636.5
otection and revetment built of brush and stone	linear feet..	6,332
d jetties built of brush and stone	do....	9,388
g walls at Hudson, built of piles, timber, brush, and stone	do....	2,965
g channel through Hudson Bar	cubic yards..	8,694
g channel through Catfish Bar	do....	14,000
g at head of lake, Hudson and Catfish bars	do....	62,473.95
s removed	number..	20
es removed	do....	2
s broken	do....	1

ork is in the collection district of Minnesota of which St. Paul is the port
and St. Vincent a subport. Collections for the year ending December 31,
4,865.46; value of domestic exports for same period, $241,195.00.

Abstract of appropriations.

roved June 18, 1878	$10,000	By act—	
roved March 3, 1879	8,000	Approved August 5, 1886	$7,500
roved June 14, 1880	10,000	Of August 11, 1888	10,000
roved March 3, 1881	8,000	Approved September 19, 1890	8,000
ed August 2, 1882	30,000	Approved July 13, 1892	8,000
roved July 5, 1884	9,000	Total	108,500

Money statement.

893, balance unexpended	$2,828.95
1894, amount expended during fiscal year	2,823.36
894, balance unexpended	5.59
894, outstanding liabilities	5.59
t (estimated) required for completion of existing project	18,200.00
t that can be profitably expended in fiscal year ending June 30, 1896	18,200.00

ted in compliance with requirements of sections 2 of river and
or acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Comparative statement of steamboats and barges, freight and passengers carried, lumber and logs towed and rafted, on the St. Croix River, Wisconsin and Minnesota, for a period of sixteen years.

STEAMBOATS AND BARGES.

Year.	In freight and passenger business.		Steamboats in towing and rafting business.	Year.	In freight and passenger business.		Steamboats in towing and rafting business.
	Steamboats.	Barges.			Steamboats.	Barges.	
1878[1]	3	.....	8	1886	6	38	49
1879	3	.....	12	1887	3	40	58
1880	3	.....	29	1888	1	3	58
1881	2	.....	40	1889	1	1	82
1882	3	24	77	1890	2	3	126
1883	3	25	51	1891	[2]1	.....	[3]130
1884	3	25	30	1892	.....	.....	[3]122
1885	4	33	50	1893	.....	.....	[3]127

[1] Amount of commerce and navigation when work of improvement began.
[2] 117 tons burden and 18 inches draft.
[3] From 35 to 240 tons burden and 2½ to 3½ feet draft.

FREIGHT AND PASSENGERS.

Year.	Freight carried.				Passengers carried.
	General merchandise.	Lumber.	Wood.	Total.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
1878[1]	Unknown.	Unknown.	Unknown.	16,000	15,000
1879	Unknown.	Unknown.	Unknown.	23,893	9,244
1880	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
1881	Unknown.	Unknown.	Unknown.	17,500	11,015
1882	Unknown.	Unknown.	Unknown.	30,000	10,300
1883	Unknown.	Unknown.	Unknown.	31,500	12,800
1884	Unknown.	Unknown.	Unknown.	40,000	4,000
1885	Unknown.	Unknown.	Unknown.	42,500	10,647
1886	Unknown.	Unknown.	Unknown.	90,450	12,756
1887	Unknown.	Unknown.	Unknown.	28,500	9,873
1888	Unknown.	5,200	4,354	9,554	Unknown.
1889	Unknown.	5,900	4,100	10,000	Unknown.
1890	209	7,139	5,796	13,144	921
1891	Unknown.	100	200	300	551

[1] Amount of commerce and navigation when work of improvement began.

RAFTED LOGS AND LUMBER.

Year.	Rafted logs towed out of St. Croix River (estimated).	Rafted lumber towed out of St. Croix River.				Total tonnage, exclusive of loose logs.	Loose logs run on river above Stillwater.	
		Lumber.	Shingles.	Laths.	Pickets.			
	Feet, B. M.	*Feet, B. M.*	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet, B. M.*	*Tons.*
1878	70,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1879	117,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1880	200,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1881	185,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1882	130,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1883	108,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1884	175,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1885	150,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1886	115,000,000	Unknown.	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1887	175,000,000	100,000,000	Unknown	Unknown	Unknown	Unknown	Unknown.	Unknown
1888	136,000,000	114,610,966	40,079,500	23,651,800	570,820	706,367	Unknown.	Unknown
1889	150,000,000	81,817,070	38,633,000	23,226,575	90,800	697,244	Unknown.	Unknown
1890	250,000,000	116,403,000	46,007,000	33,861,900	278,580	1,104,100	460,000,000	1,610,000
1891	209,233,490	110,934,084	32,016,750	31,132,350	678,240	948,757	315,231,300	1,103,310
1892	250,000,000	126,503,520	51,959,000	37,387,200	261,040	1,179,549	436,899,770	1,529,149
1893	160,000,000	63,564,209	23,196,500	18,413,720	118,580	707,745	359,468,740	1,358,141

Z 5.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

examination of this stream was made by Maj. G. K. Warren, Corps gineers, in 1866, under authorization of section 4 of the act of ess approved June 23, 1866. Major Warren's first or preliminary of this survey was rendered January 21, 1867, and printed as a f Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session. second section of the river and harbor act of Congress approved 10, 1872, provided for the survey of the Minnesota River above outh of the Yellow Medicine, which survey was made during the year, the report pertaining to which is printed in the Report of ief of Engineers for the fiscal year ending June 30, 1873. ct of Congress approved June 23, 1874, an appropriation of $10,000 ade "for the survey or improvement of Minnesota River. A sur- as made from the mouth of the river to South Bend, a distance of miles, to determine the practicability of improving navigation by of canals, locks, and dams. The results of this survey proved ossibility of a lock-and-dam navigation for the distance passed

river and harbor act of Congress approved August 5, 1886, author- survey of the Minnesota River, with a view to its improvement ks and dams. The survey, extending from the mouth of the river nkato, was made by my predecessor during the season of 1887, report thereon, with maps, rendered January 16, 1888. This was printed in House Ex. Doc. No. 158, Fiftieth Congress, first n.

following are the projects and estimates which have been sub- :

l estimate, Annual Report 1867:

Open-channel improvement, Yellow Medicine to the mouth, 237 miles	$117,000
Slack-water (locks and dams in river), Yellow Medicine to the mouth, 237 miles	775,500

channel plan (1) was approved by Congress, in appropriating 0 (March 2, 1867) for "removing snags and bowlders."

n No. 1 (see p. 364, part 1, Annual Report 1875):

ck-water (locks and dams in river), South Bend to the mouth, 16.4 miles	$733,868.63
ounts previously appropriated	87,500.00
	821,368.63

ddition to the above, the following estimates relating to the im- nent of the Minnesota River have been made, but were not con- l as having been accepted for a project:

. G. K. Warren (see p. 414, Part I, Annual Report 1875):

al from north end Lac Travers to mouth of Minnesota River, dis- nce by river, 398.13 miles; by canal, 281 miles	$12,560,000

Macomb (see p. 439, Annual Report 1873):

n-channel improvement, Minnesota Falls to mouth of Yellow Medicine, 4.65 miles	2,925

J. Allen (see p. 1580, Part III, Annual Report 1888):

k-water (locks and dams in river), South Bend to the mouth, 16.4 miles	1,883,968

appropriations up to and including that of June 18, 1878, were l to surveys and in removing snags, bowlders, etc., on the upper f the river, between Minnesota Falls and a point 30 miles below

Henderson (16.7 miles above Shakopee.) The rapidly caving banks on this stretch of the river add snags and leaning trees to the channel yearly, so that channels that were cleared thirteen years ago are encumbered with them to-day.

By the river and harbor act of August 11, 1888, Congress appropriated for—

Improving Minnesota River, Minnesota, including protecting and holding the banks opposite the borough of Belle Plaine, so as to prevent the river from cutting through the narrow neck of land at that point and thereby changing its channel and course, $10,000.

The river and harbor act approved July 13, 1892, made the sum appropriated by act of August 11, 1888, "available for the improvement of the river, omitting the requirement for operations at Belle Plaine."

Previous to last fall no money had been spent on the lower part of the river, which presents a marked contrast to the upper section.

Below Shakopee the river is, in the main, very deep, almost free from snags and caving banks, and would offer exceptional advantages to the navigation thereof were communication between it and the Mississippi River rendered permanent by the improvement at the mouth of the river.

Amount expended to June 30, 1893, including outstanding liabilities, $117,644.99.

WORK DURING THE PAST FISCAL YEAR.

During the past year, work has been confined to the mouth of the river. The plan of the improvement was fully described in my project dated August 23, 1893, from which I quote:

Deferring the question for the present of a general project for this river, the one here proposed is intended only to furnish improvement for the lower reach of the river from Chaska to the Mississippi River at Fort Snelling, a distance of 28.6 miles.

The improvement proposed will fall in accord with any general plan and will not interfere therewith.

An examination of the profile* (herewith) of the lower portion of the Minnesota River will show that below Shakopee (24.2 miles from Fort Snelling) the river, in the main, is deep and with a fall of only five-tenths of a foot in that distance. Above Shakopee, bars appear in the river, though the slope between Shakopee and Chaska (4.4 miles) is only two-tenths of a foot.

Between Chaska and Carver (2.4 miles) the bars are more numerous and the river shallower. The fall in this distance is twenty-five one-hundreths of a foot.

At the mouth of the river there are two outlets: (1) The main outlet along Pike Island and (2) the Fort Snelling Chute. Years ago this chute was used as a steamboat channel, but of late years edgings and sawdust from the sawmills in Minneapolis have been drawn in and deposited to such an extent as to prevent its use by steamboats except in high water.

It is proposed to divert the river channel from behind Pike Island to the Fort Snelling Chute.

Owing to peculiar local conditions the same means which effect this diversion will raise the river's lower pool as far up as Shakopee about one foot during low-water stages. The diversion will be effected by dredging on the line E–F (see chart*) and closing the channel behind Pike Island with a dam at C–D. The crest of this dam to be placed at an elevation of 92 feet, so that the whole discharge at ordinary and low stages will be forced through the Fort Snelling Chute.

The dam C–D will back water up the Minnesota River as far as Carver, 31 miles, and will in all probability furnish sufficient depth to enable steamboats to reach the lower end of the city at extreme low stages. Steamboats drawing 3 feet will be able to reach Chaska.

The watershed of the Minnesota is mostly under different climatic conditions from that of the Mississippi above the junction. The one lies largely amongst the arid plains of Dakota and western Minnesota, while the other covers the lake and forest region of Minnesota. As a result the Minnesota reaches its low-water stages much

* Omitted.

arlier in the season than the Mississippi, and hence at the junction it is relatively ower during those stages. Then again the Mississippi has a considerable slope long Pike Island. At low stages the fall between the head and foot of the island s between 2 and 3 feet. At such times the Mississippi overflows into the Minnesota long the Fort Snelling outlet, the difference of level being 1.5 feet in a distance of ,500 feet.

The project was approved September 1, 1893, and the improvement vas made during September, October, and November, 1893.

In my report for the month of October, 1893, the effect of the improvement was stated as follows:

After the completion of the dam and opening of the new channel soundings made up the Minnesota River gave the following depths at mean low water:

	Feet.
Up to Shakopee (24.2 miles)	6+
Up to Chaska (28.6 miles)	5
Up to lower end of Carver	4½
At Carver bridge (31 miles)	2

At extreme low water the depths would be about 1 foot less than those given above.

It will be observed that the improvement affords a navigable channel to the lower end of the town of Carver, though the project contemplated a channel to Chaska only.

The improvement was a success. It cost less than $10,000, and opening the lower 30 miles of the Minnesota River to steamboats at all stages. Steamboat-owners have made arrangements to place several boats on the river, but before doing so they are waiting to see whether the United States will repair the damages that have been done by the high water.

Recent soundings show that a deposit has taken place in the Mississippi end of the Fort Snelling cut. It is conjectured that the deposit has been caused by the wash from an old bar just above the end of the cut that has been eroded by the current induced by the draft through the cut. It was expected to have removed this bar as well as one similarly situated in the Minnesota River last fall, but the funds available were not sufficient. The deposit in the channel blocks the entrance to the cut and the river during low stages. It will be necessary to reopen the end of the cut and, in order to protect it, to dredge out the 2 bars.

On the dam the current and floating débris have carried off some of the rock crowning.

The depth of water at low stages over the improved section is governed by the height of the dam, and it is important that it be held to the height originally built. The loss of stone was anticipated, and $500 of the last appropriation has been retained to make this repair. Each recurring high water will act in the same manner, and the necessity for replacing the stone is liable to be a yearly contingency, unless means are adopted to protect it. If money should become available it is proposed to build a low pile fence on the crest of the dam. This will secure the structure for a good many years.

Amount expended during the fiscal year ending June 30, 1894, including outstanding liabilities, $9,281.01.

The sum of $35,000 can be profitably expended during the fiscal year ending June 30, 1896.

Abstract of appropriations.

By act approved—		By act approved—	
March 3, 1867	$37,500	March 3, 1875	$10,000
July 11, 1870	10,000	August 14, 1876	10,000
March 3, 1871	10,000	June 18, 1878	10,000
June 10, 1872	10,000	By act of August 11, 1888	10,000
March 3, 1873	10,000		
June 23, 1874	10,000	Total	127,500

Money statement.

July 1, 1893, balance unexpended	$9,873.55
June 30, 1894, amount expended during fiscal year	9,283.05
July 1, 1894, balance unexpended	590.50
July 1, 1894, outstanding liabilities	16.50
July 1, 1894, balance available	574.00
Amount (estimated) required for completion of existing project	693,868.63
Amount that can be profitably expended in fiscal year ending June 30, 1896	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Year.	Steamboats plying on lower part of river.			Freight carried.					
	No.	Tonnage.	Draft.	Wheat.	Hay.	Wood.	Brick.	Miscellaneous.	Total.
		Tons.	*Inches.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1888	1								3,350
1889	2	153 180	18 20						4,900
1890	3	117 153 180	18 30 20	62	809	840	1,080	842½	3,633½

There was no traffic on the river during the seasons of 1891-'92-'93, as steamboats could not pass the bar at the mouth of the river.

Z 6.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

The project for improvement of this river from Breckenridge to the northern boundary line, adopted in 1877, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars, except at Goose Rapids, where a lock and dam was proposed. The estimated cost was:

For the open-channel improvement, exclusive of Goose Rapids	$145,310.18
For lock and dam, Goose Rapids	219,287.99
Total	364,598.17

In 1883 the cost of the open-channel improvement (exclusive of Goose Rapids) was revised and placed at $179,310.18.

Until August 5, 1886, the improvement of the river, exclusive of Goose Rapids, and the improvement of Goose Rapids were considered as separate works.

In 1886-'87 they were consolidated into one, and the project for the improvement of the river was modified by substituting the open-channel methods (removal of bowlders and dredging) over Goose Rapids for the proposed lock and dam. In 1887 the cost of completing the improvement was estimated at $79,598.37, making the total cost of the improvement from commencement of work, $249,598.37. In 1893 this

increased to $67,320 for completion, or $307,320 for total cost from mencement of work.

revious to 1879, when the first bar was dredged through, the ruling th at ordinary low water between Moorhead and Goose Rapids has n stated to have been but 1½ feet, and below Grand Forks but 2 . The dredging work to June 30, 1893, has resulted in a 3-foot nnel at ordinary low water, averaging 60 feet in width, from Moor- d to a point 80 miles north, and a channel of the same width 60 es south of Grand Forks, leaving only about 15 miles of river to be roved between them, including the upper portion of Goose Rapids. m Grand Forks north, a 4-foot channel 60 feet wide to lower end of ican Bars, 95½ miles. The latter makes available the remaining gth of river to the boundary line, some 48 miles farther. In short, re remain to be improved but 15 miles (including the upper portion Goose Rapids) of the 298½ miles of river between Moorhead and the ndary line.

he river is subject to landslides. These slides can never be antici- d, form obstructions when they occur, and have to be removed in le or in part, thereby increasing the amount of the cost of the rovement. The removal of snags and trees between Moorhead and rcrombie improved that section of the stream for navigation dur- high and medium stages of water.

xpended upon the improvement from the commencement of work 77 to June 30, 1893, including outstanding liabilities, $234,828.29.

'ERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1894.

redging was continued on Goose Rapids Flats until July 24, 1893, n work was suspended until a new appropriation should become lable. The work resulted in completing the improvement by ged channels over Goose Rapids Flats, in the removal of bowlders, and in partially dredging a channel through the bar one-half mile w Goose Rapids.

he quantities of work in detail have been:

vation	cubic yards..	14,978
ing dams	linear feet..	2,295
nels cut	do....	250
lders removed	cubic yards..	21¼
s removed		30
hanging trees removed		30

or a more detailed account of the year's operations attention is ited to the report of Assistant Engineer R. Davenport, herewith.

he total work done on this stream since the first appropriation for improvement was made in 1876, and extending from Fort Aber- mbie north to the boundary line, a total river distance of 309.5 miles, s follows:

rial dredged	cubic yards..	764,140
s removed		665
lders removed	cubic yards..	431¼
hanging trees removed		8,752
ps removed		198
removed		23
piles (collection of driftwood, trees, etc.)		8
e removed		1
nel excavated	linear feet..	149,909
and training dams constructed	do....	195,475

n the portions of the river worked over by the dredges the average h of the channel has been increased from 1½ to 2 feet.

Mr. Rufus Davenport, assistant engineer upon this improvement for the past eleven seasons, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

All of the work for the improvement of this stream has been performed by hired labor.

Expended upon this improvement during the fiscal year ending June 30, 1894, including outstanding liabilities, $5,069.41.

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Approved August 5, 1886	$50,000
Approved June 18, 1878	30,000	Of August 11, 1888	20,000
Approved March 3, 1879	25,000	Approved September 19, 1890	25,000
Approved June 14, 1880	20,000	Approved July 13, 1892	25,000
Approved March 3, 1881	18,000		
Passed August 2, 1882	10,000	Total	240,000
Approved July 5, 1884	10,000		

Money statement.

July 1, 1893, balance unexpended	$7,960.50
June 30, 1894, amount expended during fiscal year	7,607.44
July 1, 1894, balance unexpended	353.06
July 1, 1894, outstanding liabilities	250.76
July 1, 1894, balance available	102.30
Amount (estimated) required for completion of existing project	67,320.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	67,320.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

ST. PAUL, MINN., *June 30, 1894.*

MAJOR: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1894, is respectfully submitted:

Dredging operations on the river were confined to a portion of the month of July, 1893 (1 to 24), during which period the work of improvement on Goose Rapids Flats was brought to a completion.

The work done consisted in the completion of the dredging of the three bars that formed the obstruction to navigation at that point, and the removal of bowlders and other obstructions from the channel.

A partial channel cutting was also made through the bar one-half mile below Goose Rapids Flats.

Total excavation, 14,978 cubic yards; channel cut, 250 linear feet; training dams formed with the excavated material, 2,295 linear feet.

(The actual length of channel excavated on Goose Rapids Flats, etc., was 4,250 linear feet; all but 250 linear feet, however, being partially completed at the time, was reported in the work done prior to June 30, 1893.)

The steamer *Ogama*, operated in connection with the dredge, in towing the fleet, keeping up the supply of fuel, subsistence, etc., made 12 trips.

Total number of miles run, 465; wood loaded, 216¼ cords. When otherwise unoccupied, the steamboat was employed in removing obstructions, in the shape of bowlders, overhanging trees, snags, etc., from the channel.

Number of bowlders removed, 71 (21¼ cubic yards); overhanging trees and snags (4 to 18 inches in diameter), 60.

Dredging, etc., in detail.

DREDGE OTTER TAIL.

Location.	Number of cut.	Excavation.	Channel cut.	Training dams.
		Cu. yards.	*Lin. feet.*	*Lin. feet.*
Sec. 2, T. 146, R. 49	1	2,022	.....	.....
Sec. 1 & 2, T. 146, R. 49	2	2,534	.....	.....
Sec. 1, T. 146, R. 49	3	9,972	.....	2,045
Sec. 36, T. 146, R. 49	4	450	250	250
Total	.....	14,978	250	2,295

Length of channel and training dams of cuts Nos. 1 and 2, and partially of cut No. 3, were returned in the report of work done prior to June 30, 1893. Owing to very heavy digging at cut No. 3, training dams were formed on both sides of that cut with the excavated material.

Cost of excavation, including cost of formation of training dams, 18.82 cents per cubic yard; cost of removal of bowlders, $4.74 per cubic yard, and of overhanging trees and snags, $1.74; cost of subsistence per ration, 40.69 cents

The cost of maintaining and operating the steamboat is included in the cost of the work as above.

After the close of the work, July 24, the dredging fleet was returned to Grand Forks, where the boats and machinery were laid up and left in the care of the watchman. The entire fleet is now in need of repair, of which the details are submitted in a separate report.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The stage of water on the Red River during the boating season of 1893 was particularly favorable for steamboat operations up to about the 1st of September, but after that date the water was reported to be too low for profitable steamboating, though in the dredged channels north of Grand Forks there was at no time less than 3½ feet of water, and generally not less than 4 feet, even up to the close of the season.

The steamer *H. W. Alsop* (150 tons), with a fleet of barges, was the only steamboat operated on the river during the season of 1893.

Under the more favorable condition for navigation south of Grand Forks, by the improvement of Goose Rapids Flats, it is now proposed to build and operate a steamboat line on that section of the river, and a company was formed this fall for that purpose.

In this connection, the statement has been made by the parties interested that 2,000,000 bushels of wheat can be had yearly for river transportation, provided that there is a reliable steamboat line on that portion of the river. The only steamboat now on the river is owned by and operated in the interest of a railroad company.

The following is a statement of the freight moved on the river in 1893:

	Tons.
To Grand Forks, N. Dak., from the north and south:	
Wheat	5,371.5
Oats	30
Wood	187.5
From Grand Forks, N. Dak., to the north and south:	
Merchandise	76
Lumber	58
Total	5,723

Comparative statement of freight moved by steamboats and barges during the past fifteen years.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1893	5,723	1888	12,140	1883	25,314
1892	14,256	1887	10,405	1882	31,652
1891	12,137	1886	10,507	1881	26,557
1890	1,710	1885	23,045	1880	21,651
1889	3,866	1884	29,046	1879	17,829

Z 7.

GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

The Board of Engineers, to whom was referred the project for the application of $37,500 appropriated by the river and harbor act of August 5, 1886, for reservoirs at the head waters of the Mississippi River, recommended in their report, dated May 24, 1887—

That such gaugings be made at or near St. Paul during the annual operation of the reservoirs as shall determine accurately the discharge at that point during critical periods (P. 1692, Annual Report Chief of Engineers, 1887).

The river and harbor act of August 11, 1888, authorized the gaugings, and provided for them as follows:

And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operations of said reservoirs as shall determine accurately the discharge at that point, the cost of the same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

* * * * * * *

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the 21st of February, 1871, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however*, That an itemized statement of said expense shall accompany the Annual Report of the Chief of Engineers.

Gaugings were not made until the fall of 1889, although an allotment for $900 for the fiscal year ending June 30, 1889, had been made. On account of the lateness of the season and the condition of the river it was not deemed advisable to expend any of the money that year.

The allotments of $600, $900, $900, $500, and $500, made for the fiscal years 1889–'90, 1890–'91, 1891–'92, 1892–'93, and 1893–'94, respectively, were applied to gauging the Mississippi River at St. Paul.

During the past year a total of 159 have been made as follows:

Table of gaugings made at St. Paul, Minn., during the fiscal year ending June 30, 1894.

[Mississippi River at Robert street bridge. Method: Ellis current meter No. 21.]

No.	Date.	Reading of signal service gauge, St. Paul, Minn.	Discharge per second.	Remarks.	No.	Date.	Reading of signal service gauge, St. Paul, Minn.	Discharge per second.	Remarks.
	1893.		*Cubic feet.*			1893.		*Cubic feet.*	
1	July 1	4.2	8,089.7		16	July 21	3.3	6,730	Strong breeze downstream.
2	July 3	4	7,928.3						
3	July 5	3.9	7,858.2		17	July 22	3.2	6,624.7	
4	July 6	3.77	7,362.6		18	July 24	2.9	5,738.5	
5	July 8	3.75	7,086.7		19	July 25	2.8	5,870.9	Breeze downstream.
6	July 10	3.9	7,825.9						
7	July 11	4	7,597.9	Strong breeze upstream.	20	July 26	2.8	6,005	Strong breeze downstream.
8	July 12	4.05	8,096.6	Strong breeze downstream.	21	July 27	2.7	5,608	
					22	July 28	2.5	5,318.9	
9	July 13	4	7,935		23	July 31	2.45	[1]5,676.8	
10	July 14	4	8,024.4	Breeze downstream.	24	Aug. 1	2.5	4,973.1	
					25	Aug. 2	2.27	4,674.5	
11	July 15	4	7,669		26	Aug. 3	2.2	4,593	
12	July 17	3.75	7,636.8	Do.	27	Aug. 4	2.2	4,631.5	
13	July 18	3.7	7,159.3		28	Aug. 5	2.1	4,517.5	
14	July 19	3.65	7,118.2		29	Aug. 7	2.05	4,491.9	
15	July 20	3.4	6,748						

[Method: Ellis current meter No. 18.]

	1893.					1893.			
30	Aug. 8	2.1	4,479.6		73	Sept. 28	2.75	5,560.8	
31	Aug. 9	1.95	4,327.2		74	Sept. 29	2.75	5,561.2	
32	Aug. 10	1.9	4,195.9		75	Sept. 30	2.95	5,933.5	
33	Aug. 11	1.85	4,293.6	Strong breeze downstream.	76	Oct. 2	2.9	6,045.5	
					77	Oct. 3	2.7	5,379.4	
34	Aug. 12	1.9	4,368.3		78	Oct. 4	2.6	5,507.9	
35	Aug. 14	2.15	4,957.4	Do.	79	Oct. 5	2.8	5,855.6	
36	Aug. 15	2.3	4,913.6		80	Oct. 6	3.2	6,538.2	
37	Aug. 16	2.35	5,192.2		81	Oct. 7	3.2	6,477.4	
38	Aug. 16	2.35	[2]5,153.7		82	Oct. 9	2.95	6,253.3	
39	Aug. 17	2.3	4,814		83	Oct. 10	2.87	5,988.2	
40	Aug. 18	2.15	4,633		84	Oct. 11	2.7	5,967.5	
41	Aug. 19	2.2	4,902.1		85	Oct. 12	2.9	6,171.6	
42	Aug. 21	2.22	4,795.9		86	Oct. 13	2.8	5,732.4	
43	Aug. 22	2.2	4,737.4		87	Oct. 14	2.75	6,071.3	
44	Aug. 23	2.1	4,515		88	Oct. 16	2.75	5,872.4	
45	Aug. 25	2.1	4,439.9		89	Oct. 17	2.85	5,997.1	
46	Aug. 26	1.9	4,275.4		90	Oct. 18	2.8	6,141.1	
47	Aug. 28	2.12	4,687.5		91	Oct. 19	2.85	6,114.9	
48	Aug. 29	2.47	5,133.5		92	Oct. 20	2.9	6,220.1	
49	Aug. 30	2.62	5,584.4		93	Oct. 21	2.85	6,124.3	
50	Aug. 31	2.62	5,546.4		94	Oct. 23	2.9	6,205.4	
51	Sept. 1	2.85	6,074.3		95	Oct. 26	2.825	6,388.7	
52	Sept. 2	3.05	6,132		96	Oct. 27	2.825	5,861.3	
53	Sept. 5	2.85	5,851.4		97	Oct. 28	2.82	5,966.2	
54	Sept. 6	2.85	5,782.6		98	Oct. 30	2.7	5,804.4	
55	Sept. 7	2.67	5,691.8		99	Oct. 31	2.85	5,912.4	
56	Sept. 8	2.7	6,577.6		100	Nov. 1	2.65	5,799.2	
57	Sept. 9	2.7	5,624.2		101	Nov. 4	2.5	5,630.3	
58	Sept. 11	2.82	5,729.9		102	Nov. 7	2.6	5,675.8	
59	Sept. 12	2.9	5,952.1		103	Nov. 8	2.5	5,555.6	
60	Sept. 13	2.9	6,009.9		104	Nov. 9	2.35	5,449.2	
61	Sept. 14	2.95	5,988.1		105	Nov. 10	2.4	5,369.8	
62	Sept. 15	2.93	5,900.4		106	Nov. 11	2.35	5,282.9	
63	Sept. 16	2.9	5,875.5		107	Nov. 13	2.2	5,335	
64	Sept. 18	3	6,322.8		108	Nov. 14	2.35	5,353.4	
65	Sept. 19	3.08	6,218		109	Nov. 15	2.15	4,740.1	
66	Sept. 20	2.95	5,929.9		110	Nov. 16	1.9	4,407.6	
67	Sept. 21	3.1	6,052.1		111	Nov. 17	1.8	4,559.8	
68	Sept. 22	2.87	5,722			1894.			
69	Sept. 23	2.85	5,856.6		112	Apr. 6	3.07	6,553	
70	Sept. 25	2.85	5 770.7		113	Apr. 7	3.02	6,326.3	
71	Sept. 26	2.85	5,716.7		114	Apr. 10	3.2	6,618.6	
72	Sept. 27	2.85	5,840.7		115	Apr. 11	3.47	.....	Too wavy.

[1] Meter No. 18.

[2] Meter No. 21.

Table of gaugings made at St. Paul, Minn., during the fiscal year ending June
Continued.

[Method: Ellis current meter No. 18.]

No.	Date.	Reading of signal service gauge, St. Paul, Minn.	Discharge per second.	Remarks.	No.	Date.	Reading of signal service gauge, St. Paul, Minn.	Discharge per second.	
	1894.		*Cubic feet.*			1894.		*Cubic feet.*	
116	Apr. 12	3.59	7,401.5		139	June 5	6.25	[1]14,978.7	
117	Apr. 13	3.6	7,388.1		140	June 6	6.05	[1]14,063.9	
118	Apr. 14	3.59	7,403.2		141	June 7	5.79	[1]13,271.2	
119	Apr. 17	4.74	[1]10,135.5		142	June 8	5.56	[1]12,211	
120	Apr. 19	6.75	[1]16,614.9	Strong wind downstream.	143	June 9	5.3	[1]11,066.4	
					144	June 11	4.9	[1]10,271	
121	Apr. 20	8.72	25,146.8	Breeze upstream.	145	June 12	4.65	9,179.4	
122	Apr. 23	10.1	32,464.7		146	June 13	4.51	9,056.8	
123	May 10	9.21	27,138.8		147	June 14	4.37	8,988.8	
124	May 11	9.08	25,327.7		148	June 15	4.12	8,279.3	
125	May 12	8.72	24,044.6		149	June 16	4.1	8,211.5	
126	May 16	8.75	24,958.7		150	June 19	3.7	7,098.4	
127	May 17	9.55	28,889.3		151	June 20	3.6	7,002.7	Wi st
128	May 19	11.37	38,362.1						
129	May 22	11.55	38,451.4		152	June 21	3.55	6,951	
130	May 23	11.15	36,846.7		153	June 22	3.45	6,704.8	
131	May 24	10.55	33,140.6		154	June 23	3.2	6,320.9	
132	May 25	9.95	29,057.1		155	June 26	2.9	5,839.1	
133	May 26	9.31	26,690.2		156	June 27	2.85	5,717.6	
134	May 28	8.35	22,337.2		157	June 28	2.85	5,829.5	Ser de
135	May 29	7.8	20,542.6						
136	May 31	7.3	18,787		158	June 29	2.75	5,554.2	
137	June 1	7.05	17,915.6		159	June 30	2.82	5,382.7	
138	June 2	6.82	[1]16,993.4						

[1]When the Signal Service gauge reads 4.65 and upward, water passes over a closing west side of island where gauging station is located. Between stages of 4.65 and 7 it is i to measure with the meter the volume passing on west side of island, as the current is To arrive at the quantity flowing on that side, the measurement for the guage reading were platted and the curve extended to zero volume at stage 4.65.

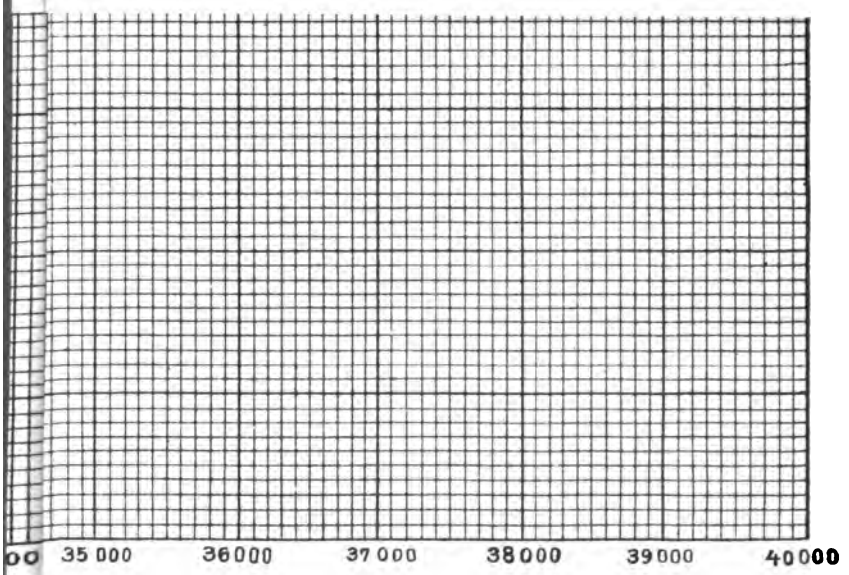
The gaugings were made by observing the mid-depth velo sections 20 feet apart. Mean velocity was taken as 95 per cen depth velocity.

The results of the gaugings are interesting and valuable they go, but I desire to repeat the recommendation contained ous annual reports that the money heretofore allotted and ma able for gauging has been inadequate to procure the informatio for a correct and scientific investigation of the effect of the water on the Mississippi River. It is imperative that this effec ascertained and established beyond question. The knowledg would be of use not only in connection with the present reser tem at the headwaters of the Mississippi River, but also in ing the value of reservoirs as a means of improving rivers in

It is recommended that Congress be asked to fix the amou annually available for this specific work.

DIAGRAM SHOWING VOLUME OF THE MISSISSIPPI RIVER AT S

The measurements taken during the four years ending June have been averaged and a diagram drawn (which is submitt with) showing the average volume corresponding to readin Signal Service gauge. In averaging the measurements it was that the curve was a straight line for each one-half foot on t



Report 1894.

Jones

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The average measurements were:

Number of observations taken.	Average gauge reading.	Average volume per second.	Remarks.
	Feet.	*Cubic feet.*	
6	0.74	2,703.34	Average between 0.50 and 0.99 on gauge.
53	1.31	3,543.48	Average between 1.00 and 1.49 on gauge.
46	1.75	4,203.10	Average between 1.50 and 1.99 on gauge.
47	2.23	4,906.55	Average between 2.00 and 2.49 on gauge.
100	2.75	5,811.17	Average between 2.50 and 2.99 on gauge.
30	3.17	6,567.03	Average between 3.00 and 3.49 on gauge.
26	3.72	7,534.30	Average between 3.50 and 3.99 on gauge.
17	4.16	8,400.75	Average between 4.00 and 4.49 on gauge.
20	4.75	9,833.93	Average between 4.50 and 4.99 on gauge.
16	5.19	11,291.54	Average between 5.00 and 5.49 on gauge.
8	5.74	13,226.86	Average between 5.50 and 5.99 on gauge.
10	6.25	15,079.12	Average between 6.00 and 6.49 on gauge.
8	6.75	16,908.80	Average between 6.50 and 6.99 on gauge.
4	7.24	18,895.62	Average between 7.00 and 7.49 on gauge.
3	7.79	21,327.20	Average between 7.50 and 7.99 on gauge.
4	8.23	23,191.35	Average between 8.00 and 8.49 on gauge.
6	8.76	24,855.07	Average between 8.50 and 8.99 on gauge.
4	9.17	26,698.05	Average between 9.00 and 9.49 on gauge.
2	9.75	28,973.20	Average between 9.50 and 9.99 on gauge.
1	10.10	32,464.70	Average between 10.00 and 10.49 on gauge.
1	10.55	33,140.60	Average between 10.50 and 10.99 on gauge.
2	11.26	37,604.40	Average between 11.00 and 11.49 on gauge.
1	11.55	38,451.40	Average between 11.50 and 11.99 on gauge.

The observed measurements fluctuated considerably for same gauge reading, depending upon the force and direction of the wind and whether the river was rising or falling.

Amount expended during the fiscal year ending June 30, 1894, including outstanding liabilities, $500.

Abstract of allotments.

For fiscal year ending June 30—	
1889	* $900
1890	600
1891	900
1892	900
1893	500
1894	500
1895	500

Money statement.

July 1, 1893, balance unexpended	$113.99
Amount allotted for fiscal year ending June 30, 1894	500.00
	613.99
June 30, 1894, amount expended during fiscal year	592.06
July 1, 1894, balance unexpended	21.93
July 1, 1894, outstanding liabilities	21.93
Amount allotted for fiscal year ending June 30, 1895	500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	4,600.00

* Not used.

Itemized statement of expenditures during the fiscal year ending June 30, 1894.

Date.	To whom paid.	For what paid.	Amount.
1892.			
Aug. 1	Sundry persons	Pay roll for July 1, 1893	$79.17
Sept. 2	....do	Pay roll for August, 1893	60.00
Oct. 3	....do	Pay roll for September, 1893	247.50
Nov. 11	....do	Pay roll for October, 1893	60.00
Nov. 23	E. A. Brown	Timer	7.65
Nov. 23	F. J. Renz	Job work	2.75
Nov. 23	Miles & Hale	Keys	2.00
Nov. 28	St. Paul Hardware Co	Chains	.38
Nov. 28	Beacon Electric Co	Okonite and battery	1.45
Dec. 20	Robinson & Cary	Wire rope	7.50
Dec. 20	Scribner-Libby Co	Lead weights	2.32
1893.			
Apr. 14	J. H. Ballard	Drayage	.50
June 8	American Express Co	Express charges	.60
June 8	Soren Denesen	Washing towels	4.50
June 29	John E. Dempsey	Office blanks	1.75
	Total		478.07

Outstanding liabilities June 30, 1894.

To whom owing.	On account of—	Amount.
Goodyear Rubber Co	Rubber boots	$4.52
Minnesota Engine Works	1 sounding lead	3.98
St. Paul Hardware Co	Chain, staples, etc	3.25
Do	Office supplies	.50
P. Pederson	Repairing current meter	3.00
Beacon Electric Co	Dry batteries	2.25
Robinson & Cary Co	Rope	2.03
Boeringer & Son	Cleaning register	1.50
T. A. Marshall	Office supplies	.56
John W. Lane	Notarial fee	.25
Total		21.93
Expended during the fiscal year ending June 30, 1894		478.07
Total		500.00

Z 8.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF MISSISSIPPI, ST. CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for such work. For account in detail of these surveys reference is made to pp. 1507 and 1508, Appendix Y, Part II, Annual Report of Chief of Engineers, 1886.

It has been demonstrated that the reservoir system at the sources of the Mississippi River increases the navigable capacity of the Mississippi River at St. Paul at least 1 foot during low-water seasons. It is simply a question of more or less water collected as to whether the improvement shall be more or less than that. More water must of necessity improve a river for navigable purposes, and hence I think it advisable to see whether the great collecting capacity of the watershed of the Crow Wing River can not be added to the present supply at a reasonable cost. It is therefore recommended that the sum of $5,000 be expended in making an examination and survey of the basin of Crow Wing River, with a view to determine whether its waters can be added to the reservoir system at a reasonable cost.

It is to be particularly noted that although the steamboat navigation above Minneapolis is at present insignificant, the time is pretty sure to come when it will be important; and, furthermore, there is to-day an enormous commerce upon these waters. The great mass of floating logs is nothing more or less than a commercial product being moved to market by the cheapest known form of transportation. The actual annual tonnage of products of the forest thus moved to market is considerably in excess of 1,000,000 tons, and the tonnage is rapidly increasing.

This is a commerce worthy of attention and consideration.

Money statement.

Amount (estimated) required for completion of existing project	$50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

APPENDIX AA.

IMPROVEMENT OF MISSOURI RIVER ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Missouri River between the Great Falls, Montana, and Sioux City, Iowa.
2. Removal of snags and other obstructions in Missouri River above Sioux City, Iowa.
3. Examination of Missouri River between Three Forks and Canyon Ferry, Mont., to determine availability of water power.
4. Yellowstone River, Montana and North Dakota.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, July 14, 1894.

GENERAL: I have the honor to transmit herewith reports upon the works in my charge for the year ending June 30, 1894.

Very respectfully, your obedient servant,

H. F. HODGES,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

AA 1.

IMPROVEMENT OF MISSOURI RIVER BETWEEN THE GREAT FALLS, MONTANA, AND SIOUX CITY, IOWA.

APPROVED PROJECT.

From the Great Falls to Fort Benton the Missouri River is so much obstructed and has so steep a slope that no improvement for purposes of navigation seems practicable, and none has ever been attempted. Between Fort Benton and Carroll, 168 miles below, the stream has a rocky and gravelly bed, clear water, and naturally stable banks. The project for the improvement of this stretch, which is known as the Rocky River, contemplates removal of rocks, construction of closing

and wing dams, some dredging, and the completion of a detailed survey. This project is assumed to date from the appropriation of 1882; the total estimate for its completion is $556,028.45. Previous to its adoption a sum of $157,263 had been spent on the river above the Yellowstone.

At Carroll the bed of the river becomes sandy, and finally, near the Dry Fork, 330 miles below Fort Benton, the stream assumes the characteristics of the lower reaches, having unstable banks, muddy water, and a shifting channel. The project for the improvement of this reach contemplates the removal of bad bars by sluicing, the construction of two ice harbors, and the completion of a detailed survey.

The rectification of the river fronts at the cities of Pierre and Yankton, S. Dak., has also been authorized by Congress, but no funds have been appropriated sufficient to warrant beginning the work.

APPROPRIATIONS.

The appropriations for the river above Sioux City have been as follows:

1876	$20,000	1884	$140,000
1878	30,000	1886	60,000
1879	50,000	1888*	50,000
1880	35,000	1890	300,000
1881	55,000	1892	150,000
1882	100,000		

In addition to the above-specified amounts a sum of about $74,000 from the appropriations for the survey of the river from Fort Benton to the mouth, was spent on the part above Sioux City.

CONDITION AT BEGINNING OF YEAR.

At the beginning of the fiscal year the condition of the different parts of the work was as follows:

Rocky River.—The most needed contraction work had been built, and the most dangerous bowlders removed. Some dredging had also been done, and a navigable depth of 30 inches at low water obtained for the greater part of the reach, the worst remaining shoals showing a low-water depth of 18 inches. The plant was laid up at Judith, Mont., and the work suspended, boats having ceased running on this part of the river.

The work had been carried on under an allotment of $70,000 from the appropriation of 1890, of which a balance of $12,905.15 remained in hand at the beginning of the year.

Removal of obstructions.—A fleet of two snag boats and one snag scow was available for this work, these boats having been bought or constructed from the funds available for river improvement. They had been at work since the season of 1891–'92 removing snags and similar obstructions and sluicing temporary channels through shallow bars. They were operated under the allotments, aggregating $185,000, from the general appropriations of 1890 and 1892, of which a balance of $35,175.67 was available at the beginning of the year.

Ice harbors.—By the river and harbor act of September 19, 1890, two ice harbors were authorized to be placed at points selected by the Secretary of War. At the beginning of the year the location for one of

* Allotment from general appropriation for the improvement of the river from Fort Benton to the mouth.

ise had been fixed at Rockhaven, near Mandan, N. D., and a project the construction had been submitted and approved. This project ntemplated the acquisition of a strip of land 1 mile long on the right nk of the river, at a place where the natural configuration of the er and bank causes the ice to run clear of the latter; to grade the nk on a smooth slope to the low-water mark; to construct a bank or ee at the top of the graded slope, the upper surface to be above high ter; to plant mooring posts; to form the upper end of the levee into rojecting spur dike; to construct an incline for hauling out vessels the lower end, and to dredge or sluice to a low-water depth of 4 t along the front. An allotment of $35,000 from the appropriation 1890 was available for the construction.

No work had been done toward the execution of this project, as there s delay in obtaining title to the necessary land.

The position of the second of the two harbors had not yet been fixed. location at the mouth of the Big Sioux River had been recommended the purpose by the Engineer Department.

River survey.—The completion of this work, begun by the Missouri ver Commission, was in progress under allotments aggregating 40,000 from the appropriations of 1890 and 1892.

The field work from Fort Benton to Sioux City was completed, with exception of the duplication of the line of levels between Chamber- n and Sioux City, the topography of the wide bottom between nkton and Sioux City, and the topography and hydrography between ow Creek and Chamberlain.

The plotting had been begun on two series of charts. The first, or tail charts, were finished for a distance of 885 miles below the origin, Fort Benton, and partially finished for the rest of the way. They re in process of publication on scales of $\frac{1}{7200}$ for the part of the er above the Yellowstone and $\frac{1}{12000}$ for the part below. Fifty charts re in the hands of the printer, and editions of 13 had been received d accepted.

The series, when finished, will number 198 charts.

The second series of small scale maps were plotting on a scale of $\frac{1}{380}$, or 2 inches to the mile. About 600 miles of the river had been ished.

The complete series will number 57 maps.

Rectification.—The river and harbor act of 1892 appropriated $150,000 the Missouri River between Great Falls and Sioux City, and author- d the Secretary of War to use a portion of it for rectification and nk protection at Pierre and Yankton. The whole of the appropria- n was needed for the work of the survey and snag boats, which had ready been undertaken, and, in consequence, none was allotted to the ctification work, which has not yet been begun.

OPERATIONS DURING YEAR.

Rocky River.—The execution of the project has been suspended, as ere is no present commerce on this stretch of the river. During the nths of July, August, and September the plant formerly in use here, ich had been stored at Judith, Mont., was put in repair and floated wn to Rockhaven and the Big Sioux River. The total expenditures m the allotment have been $4,752.38.

Removal of snags, etc.—The sundry civil act of 1893 appropriated 0,000 for the work of removing obstructions in the Missouri River ove Sioux City. This amount became available on July 1, 1893, at

which time the maintenance of the snag boats was transferred from the general work of river improvement to the special work created by the new act. The total expenditures from the allotment of the general appropriations of 1890 and 1892 have been $16,847.79, for liabilities incurred before the beginning of the year.

Ice harbors.—The purchase of about half of the tract required for the harbor at Rockhaven, was completed in December, 1893. The remainder is held by several persons, who own undivided interests. Deeds from all of these persons have been obtained, after considerable delay, occasioned by difficulty in finding certain of the nonresident owners. The purchase will be completed as soon as the title has been verified and accepted by the Attorney-General.

In May, 1894, the work was begun by hired labor on the part of the tract already in the possession of the United States. A levee, with the top 32 feet above low water, has been constructed to grade for a distance of 1,300 feet along the bank, or about one-fourth of the total projected length. The slopes have been finished to the water's edge. Ten steel-tube mooring posts have been made and put in place, being anchored with blocks of concrete. The remainder of the work on the part of the land already acquired will be finished soon. The work has been under the immediate charge of Mr. H. C. Gould, assistant engineer, assisted by Mr. E. A. D. Parker, as overseer. The total expenditures from the allotment have been $5,233.89.

The location for the second of the two ice harbors authorized by the river and harbor act of 1890 was selected by the Secretary of War under date of February 8, 1894. The place chosen was in the mouth of the Big Sioux River, a locality which had been recommended by the Engineer Department in June, 1891. Upon notification that the site had been selected, a project for the work was prepared and submitted under date of April 4 and approved April 19, 1894. This project contemplates the acquisition of a strip of land 2,720 feet long along the right bank of the river, the construction of a levee with the top above extreme high water, grading the bank to a suitable slope, placing mooring posts at convenient intervals, and grading an incline for hauling out boats. A sum of $11,725 was available for the construction work. Before the land can be acquired the consent of the State of South Dakota is necessary. This can not be obtained until the next meeting of the legislature, in December, 1894. Until then no work can be undertaken.

The owners of the land in question have agreed to sell it at a satisfactory price. No expenditure has yet been made from the allotment for construction. The preliminary work of surveying and mapping the locality chosen was done by Mr. W. G. Price, assistant engineer, and the expenses were paid from an allotment made for this purpose from the appropriation of 1890.

River survey.—The small amount of field work left undone at the close of the last season was finished during the summer and autumn of 1893. The completion of the line of levels and the work between Crow Creek and Chamberlain was done by a party under charge of Mr. C. W. Williams, assistant engineer. The topography between Yankton and Sioux City was taken by a party under charge of Mr. W. D. Fairchild, topographer.

The plotting of both series of charts was continued. At the end of April, 1894, the detailed charts were finished with the exception of a small amount of retouching and cleaning, and the force which had been at work on them was discharged. At the close of the year the series of

small scale maps was about four-fifths finished, 28 maps having been plotted during the year.

The printing of the detail charts has been continued by the firms of Julius Bien & Co., of New York, and the Forbes Lithograph Manufacturing Company, of Boston, Mass. Editions of 101 charts have been received during the year and satisfactory proofs of 8 more. Of the 198 charts which make up the series 114 editions are complete.

During the year Bien has furnished 69 editions and Forbes 28.

The plotting has been done under the supervision of Mr. F. M. Towar, assistant engineer. A history of the work of the survey, prepared by him, is appended as a valuable addition to this report.

The channel distances to prominent river points, and a list of the positions and elevations of the permanent bench marks, as well as a description of those leveled to in the summer and autumn of 1893, are also appended. The recorded elevations above the gulf were obtained by a connection at Sioux City with the levels of the Missouri River Commission.

Physical data.—Gauge reports have been received during the year from the following stations, viz: Townsend, Fort Benton, Judith, and Wolfpoint, Mont.; Fort Buford and Bismarck, N. Dak.; Running Water, S. Dak., and Sioux City, Iowa. The reports from the first and last of these stations are received by permission of the Missouri River Commission, by which the gauges are operated. The remaining stations are occupied by gauges maintained from this office.

At stations where there are no bridges available the gauges consist usually of a horizontal beam projecting from the bank and fixed to the top of a series of piles or posts driven into the ground. The beam is marked with a scale divided usually into feet and tenths, and has a sheave at the outer end over which a wire cable runs carrying a weight at one end and a handle with index at the other. The position of the index on the scale when the weight touches the water gives the reading of the gauge.

Great trouble has been experienced on account of the displacement of the supports by the cutting away of the bank. After each removal the services of a leveler are necessary to reset the gauge. A design prepared by Assistant Engineer H. C. Gould is now under consideration, in which the supports are placed farther back from the edge of the bank, and the horizontal beam rolled out and in on wheels. Should trial with this form prove successful it is proposed to adopt it for all the bank stations.

The compilation of the gauge reports was done by Mr. H. C. Gould, assistant engineer, until April 29, and since that date by Mr. F. M. Towar, assistant engineer.

In August, 1893, a party under charge of Mr. W. G. Price, assistant engineer, began a series of low-water discharge measurements at the nearest available points below the principal tributaries.

The results of these measurements are as follows:

Station.	Location.	Date.	Stage above assumed low water.	Area.	Mean velocity (ft. per sec.).	Discharge.	Remarks.
		1893.	*Feet.*	*Square feet.*		*Cubic feet.*	
Great Falls	300 feet below mouth of Sun River	Aug. 15	1.16	7,449.4	0.5051	3,763.1	Wind light downstream.
Do	do	Aug. 16	1.15	7,411.7	.5757	4,266.6	Wind very light from left bank.
Do	One-third mile below Falls	Aug. 18	1.12	2,793	1.7138	4,786.7	No wind.
Fort Benton	700 feet above wagon bridge	Aug. 20	1.09	2,078.7	2.1226	4,412.5	Do.
Do	do	Aug. 21	1.08	2,045.9	2.1060	4,308.7	Wind light downstream.
Do	do	Aug. 22	1.07	2,019.6	2.1154	4,272.2	Strong downstream wind.
Wolfpoint	1 mile above landing	Aug. 23	.85	2,266.3	2.3694	5,669.8	Strong upstream wind.
Do	do	Aug. 24	.83	2,320.2	2.3501	5,452.7	No wind.
Fort Buford, Missouri River	At ferry, 1 mile above Yellowstone	Aug. 27	2.46	1,917.2	2.8748	5,511.7	Strong downstream wind.
Do	do	Aug. 27	2.56	1,859.4	2.7622	5,156	Light downstream wind.
Fort Buford, Yellowstone River	1 mile above Missouri River	Aug. 28	.....	4,063.8	2.2985	9,340.8	Wind very light downstream.
Fort Buford, Missouri River	Below Yellowstone	Aug. 29	2.71	6,051.3	2.3551	14,251.7	Wind very light from right bank.
Do	do	Aug. 30	2.63	5,957.4	2.2710	13,529.5	No wind.
Bismarck	2,000 feet below railroad bridge	Sept. 4	2.59	4,195.7	3.3477	14,045.8	Very light wind from left bank.
Pierre	Opposite power-house	Sept. 8	2.39	6,665.4	2.2748	13,162.4	Strong wind from right bank.
Running Water	Three-fourths mile below warehouse	Sept. 13	2.21	4,994.8	2.9278	14,623.6	Wind medium diagonally upstream from right bank.
Do	do	Sept. 13	2.20	4,879.6	3.0386	14,827	Wind strong downstream.
Vermillion	One-fourth mile above Andersons	Sept. 15	*2.30	7,251	2.1214	15,382.6	Wind strong diagonally downstream from left bank.
Sioux City †	Three-fourths mile below Omaha railroad bridge.	Sept. 18	2.06	6,065.7	2.4790	15,037.1	Wind strong diagonally downstream from right bank.
Do	do	Sept. 19	1.98	6,074.9	2.3891	14,513.7	Wind very light diagonally downstream from left bank.
Do	do	Nov. 7	2.60	6,484.6	2.408	15,614.6	Wind very light upstream.
Do	Between Perry Creek and Big Sioux	Nov. 9	2.68	6,187.6	2.560	15,840.7	Moderate wind from right bank.
Do	do	Nov. 13	2.58	6,245.1	2.698	16,847.8	Strong downstream wind.
Do	do	Nov. 15	2.53	5,901.4	2.593	15,301.6	Very light wind from right bank.

* Probable. † Sioux City gauge on Omaha railroad bridge. Assumed low water, 667.37.

The methods adopted are described in Mr. Price's report, which is appended.

At the time of the observations the river was at an ordinary stage for the autumn boating season. It will be noted that between the mouth of the Yellowstone at Fort Buford and Sioux City, 950 miles below, there is but a slight gain in the low-water discharge; and that at the time of the measurements the Yellowstone was carrying much more water than the Missouri above Fort Buford. The loss of volume between Great Falls and Fort Benton, 50 miles below, is also noteworthy. As to this point, the last season's measurements confirm others previously made for a different purpose.

The observations were continued at Sioux City at intervals during the winter to determine the effect of the ice upon the discharge. A summary of these results is below:

Discharge measurements through ice.

Date, 1894.	Gauge reading above assumed low water.	Area.	Mean velocity (feet per second).	Discharge (feet per second).	Remarks.
	Feet.	*Sq. feet.*			
nuary 10	2.31	5,011.8	2.138	10,715.3	River frozen. Gauge read to bottom of ice.
anuary 11	2.31	4,991.9	2.162	10,793.4	Do.
anuary 12	2.43	5,172.1	2.203	11,392.2	Do.
anuary 13	2.43	4,995.7	2.225	11,116.1	Do.
anuary 16	2.49	5,221.7	2.194	11,455.6	Do.

During the spring rise a series of observations was taken at Sioux City to determine the high-water discharge.

The results are tabulated below:

High-water discharge measurements.

Date.	Gauge reading above assumed low water.	Area.	Mean velocity, (feet per second).	Discharge (feet per second).	Remarks.
1894.	*Feet.*	*Sq. feet.*			
larch 21	7.32	10,502.5	6.420	67,428.2	River open.
larch 23	6.11	11,577.4	5.124	59,320.9	Do.
pril 5	5.03	9,210	4.870	44,854.8	Do.
pril 7	4.83	9,105.6	4.738	43,144.1	Do.
pril 9	5.48	9,926.3	4.873	48,374.9	Do.
pril 11	10.23	17,599.2	7.126	145,460.4	Do.
pril 12	11.98	23,938.1	8.333	199,477.7	Do.
pril 13	11.78	22,794.6	7.871	179,417.3	Do.
pril 14	9.93	19,186.4	6.560	125,869.4	Do.

Extreme high water is 18.5 feet and ordinary high water is 12.3 feet above assumed low water.

Rectification work.—The funds appropriated for the river improvement have not been sufficient to allow the authorized work at Pierre and Yankton to be undertaken. No other rectification work is projected at present.

WORK REQUIRED.

To complete the existing project on the Rocky River will require an expenditure of $185,345.46. A sum of $8,152.77 is still on hand from previous appropriations and reserved for use on this part of the river.

It will suffice for such operations as are probable for the year ending June 30, 1896. It is expected to complete the ice harbors, the survey, and the publication of charts from funds now in hand for those purposes. The appropriation of $50,000 contained in the sundry civil bill of 1893, for the removal of snags, etc., is now exhausted. There remains on hand a balance of the allotment for snagging from the appropriation of July 13, 1892, for the general river improvement sufficient to maintain the boats until about the middle of September. Unless a further appropriation becomes available before that time the work of the boats will have to be suspended.

The radical improvement of the sandy part of the river between Sioux City and Carroll has not yet been undertaken by the United States.

In the Annual Reports for 1892 and 1893 funds were asked for beginning this work on two reaches of the river, but none have yet been appropriated for the purpose. From the results of the survey, which has been practically finished in the last year, the magnitude of the work can be estimated. From the mouth of the Yellowstone to Sioux City the river has nearly the same low-water discharge, sufficient for a channel 600 feet wide, with a probable available depth of 8 feet. To obtain this it will be necessary to undertake contraction and regulation work throughout the whole reach of 950 miles. The cost of such work is difficult to state with accuracy, as none has yet been attempted on the upper river. An estimate based on a study made during the past year of the maps covering a reach of 136 miles indicates a probable average cost of $38,500 per mile at the unit prices of similar work on the river below Kansas City. Such an expense is, in my opinion, out of proportion to the public benefit probable through the growth of any navigation which can be supported by the present sparse population of the upper valley.

The increase in value of the bottom lands accruing through security against erosion would be undoubtedly very great, but such an improvement has not yet been accepted by the United States as a sufficient basis for the expenditure of public funds. For the present, therefore, no appropriation is asked for regulation work in extension of that already authorized at the cities of Pierre and Yankton. The experience to be gained at these points will show whether the cost of the work over the whole river can be made commensurate with the benefits to commerce.

At both cities the proposed improvements are for the purpose of restoring the steamboat landings. The estimates given in previous annual reports were intended to cover the cost when the works were considered as part of a series, and protected by others above and below from flanking by the current. When standing by themselves, they should be extended some distance beyond the actual front of the towns, to points above and below where the banks are stable and the natural low-water channel of approximately the same dimensions as that to be created by the regulation works; otherwise, the latter might be destroyed by shifting of the channel, or the sudden change in dimensions might cause ice gorges. The estimates will therefore require modification.

At Pierre the channel should be confined for a distance of 7 miles in length, at an estimated cost of $360,000.

At Yankton the conditions have changed within the last year and are still changing to such an extent that a close estimate of the cost of the necessary work can not be made. It must go at least 4 miles above the town, to the site of a proposed railroad bridge, and should extend for about 8½ miles. It will probably cost $450,000.

work of the snag boats is necessary, for the reasons given in the of their special work. The sum of $50,000 annually is asked continuance, in case this amount fails to be made as an annual priation.

Money statement.

ber 9, 1893, received, refundment of overpayment	$45.48
, 1893, balance unexpended	160,127.47
	160,172.95
0, 1894, amount expended during fiscal year	67,108.47
, 1894, balance unexpended	93,064.48
, 1894, outstanding liabilities	17,092.44
1894, balance available	75,972.04
int (estimated) required for completion of existing project	*170,000.00
int that can be profitably expended in fiscal year ending June 30, 1896	*500,000.00

mitted in compliance with requirements of sections 2 of river and bor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

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ts of proposals for repairs and alterations to United States snag boat James B. erson, received and opened by Capt. H. F. Hodges, Corps of Engineers, at 2:30 k November 30, 1893, under advertisement dated October 30, 1893.

Name and address of bidder.	Mild steel (per pound).	Working old steel (per pound).	Rudders.	Total (estimated).
	Cents.	*Cents.*		
n Works, Dubuque, Iowa[1]	12	6	$475	$4,375
undry and Machine Works, Sioux City, Iowa	15½	14	430	5,225
pencer, sr., Sioux City, Iowa	20	15	650	7,300

[1] Contract awarded Iowa Iron Works.

of bids for furnishing coal for United States snag boats, received and opened by Capt. H. F. Hodges, Corps of Engineers, April 2, 1894.

nd address of idder.	Sioux City, Iowa.		Running Water, S. Dak.		Chamberlain, S. Dak.		Pierre, S. Dak.		Total.	Remarks.
	Price per ton.	Amount.	Price per ton.	Amount.	Price per ton.	Amount.	Price per ton.	Amount.		
wers Coal Co., ity, Iowa.	$3.20	$736.00	$4.45	$534	$4.95	$495	$4.80	$960	$2,725.00	Mystic or Walnut block.
ark, Running S. Dak.	.....	.....	5.75	690	.....	.....	.....	.....	690.00	Iowa. Informal.
erist, Sioux wa.	3.26	749.80	4.60	552	5.10	510	4.95	990	2,801.80	Informal.
nway, Sioux wa.[1]	3.01	692.30	4.25	510	4.75	475	4.60	920	2,597.30	Do.

[1] Contract awarded E. A. Conway.

* Exclusive of $50,000 annually for removal of snags, etc.

COMMERCIAL STATISTICS.

River tonnage between Sioux City, Iowa, and Fort Benton, Mont.

[Exclusive of live stock.]

	Tons.		Tons.
1887	13,961	1891	13,055
1888	12,895	1892	15,182
1889	16,724	1893	13,837
1890	13,326		

Traffic by river reaches.

Year.	River reaches between—	Packages and bulk freight.	Passengers.	Live stock.
		Tons.	*No.*	*Head.*
1890	Sioux City and Bismarck	9,735	4,322	2,974
	Bismarck and Fort Buford	2,467	184	43
	Fort Buford and Fort Benton	1,124	62	43
1891	Sioux City and Bismarck	10,410	1,749	4,653
	Bismarck and Fort Buford	2,645	130	58
1892	Sioux City and Pierre	2,634	32	6,045
	Pierre and Bismarck	7,247	177	2,315
	Bismarck and Fort Buford	5,301	278	300
1893	Sioux City and Pierre	5,456	12,513	23,127
	Pierre and Bismarck	6,256	137	29
	Bismarck and Fort Buford	2,125	12	1

List of steamers plying on the Missouri River between Sioux City, Iowa, and Fort Benton, Mont., during the year 1893.

Name.	When built.	Dimensions.			Tonnage.	Manager or owner.
		Length.	Breadth.	Depth.		
		Feet.	*Feet.*	*Feet.*		
A. S. Bennett*	1880	115	30	3.5	78.08	R. A. Talbot, Sioux City, Iowa.
Mary E. Bennett	1888	65	14	2	21.71	Do.
Capitola Butt	1885	83.7	23.3	3.3	57.31	E. A. Conway, Sioux City, Iowa.
Vint Stillings	1881	131	31.6	4.8	177.47	Selzer Bros., Sioux City, Iowa.
Josie L. K	1884	60	14	2.5	22.75	A. Larson, Yankton, S. Dak.
Little Maud	1882	92	20	3.4	58.66	Jos. Leech, Running Water, S. Dak.
Last Chance	1870	98.2	17.8	3	50.47	H. J. King, Chamberlain, S. Dak.
Jas. Leighton	.....	.....	.....	.....	57.29	F. Horn, Pierre, S. Dak.
Castalia	1892	.....	.....	.....	75	B. S. Holmes, Sioux City, Iowa.
Batchelor	.....	178.6	31	4	313	I. P. Baker, Bismarck, N. Dak.
Rosebud	1887	177.4	31.3	4	286.49	Do.
Imelda	.....	.....	.....	.....	15	D. B. Weatherbe, Fort Yates, N. Dak.
Ida Blanche	.....	90	17	2	30	Jesse Brown, Sioux City, Iowa.

*Wrecked on river bank, Covington, Nebr.

Dates of ice closings and openings on the Missouri River above Sioux City, Iowa, 1893-1894.

[Continued from p. 2303, Report for 1893.]

Locality.	1893, closing.	1894, opening.
Montana:		
Townsend	Dec. 9	Mar. 22
Fort Benton	Dec. 1	Mar. 13
Wolfpoint	Nov. 23	Apr. 1
North Dakota:		
Fort Buford	Nov. 26	Mar. 18
Bismarck	Nov. 22	Mar. 19, Apr. 1
South Dakota:		
Running Water	Nov. 24	Mar. 10
Iowa:		
Sioux City	Nov. 29	Mar. 4

SURVEY OF THE MISSOURI RIVER FROM FORT BENTON TO SIOUX CITY.

HISTORY OF SURVEY.

he survey of the Missouri River between Fort Benton and Sioux City was begun art of a work intended to extend from Fort Benton to the mouth of the river. first appropriation for this was in 1878. From then until 1882 specific appropri- ns were made for the survey; after that year it was carried on under allotments n general appropriations for the improvement of the river.

n 1884 the charge of the survey passed into the hands of the Missouri River Com- sion, together with the rest of the river improvement. By the river and harbor of 1890 the river was divided at Sioux City, and the part from that point to the at Falls was taken from the Missouri River Commission and put under the direct trol of the Chief of Engineers. The completion of the survey over the upper t of the river reverted to his control with the rest of the improvements.

he general scheme of the survey was to carry a system of secondary triangulation ween the bluffs, the sides of the triangles being from 3 to 10 miles long, and the tions permanent; to run a duplicate line of primary levels with permanent bench rks along the whole length of the reach surveyed; to take the topography of the ole bottom between the bluffs, checking the work by tertiary triangulation; and take a sufficient number of soundings to show accurately the configuration of the er bed.

When the charge of the work was assumed in the autumn of 1890, the secondary tri- gulation was complete, and the levels had been run as far as Trover Point, ntana.

The topographical and hydrographical work had been commenced in June, 1889, at rt Benton, Mont., under the direction of the Missouri River Commission, and der the immediate supervision of Lieut. H. M. Chittenden, Corps of Engineers, S. Army.

Only 42 miles of river were completed during the first year, viz, from Fort Benton, nt., to Coal Banks Landing, Montana. In 1890, under the same direction and pervision, more progress was made, the survey being completed from the latter ace to Wolfpoint, Mont., a distance of 353 miles.

During these two years the topography was taken by a single party, running a e along the river, locating the bluffs by intersecting angles from the stadia sta- ns, and only the river bars and banks by direct stadia readings.

n 1891, after transfer from the Commission, the work was continued under the ection of Capt. C. F. Powell, Corps of Engineers.

The strength of the survey party was increased by adding two more topograph- l parties. in order to get the contours of the bluffs more accurately, and there re two instead of one complete survey parties placed in the field. One primary el party was at work. This year the topography was finished from Wolfpoint, nt., to Cannonball River, North Dakota, a distance of 491 miles, and the primary els as far as Washburn, N. Dak.

Two parties were again sent into the field in 1892, and completed the topography n Cannonball River to Sioux City, a distance of 592 miles, with the exception of ap of 20 miles next above Chamberlain and part of the work in the wide bottom ow Yankton. Two primary level parties completed one line to Sioux City, and duplicate line to Chamberlain.

n 1893 the work was transferred to Capt. H. F. Hodges by Capt. Powell. In June pographic party was sent out to get the topography of the wide bottom lands and adjacent bluffs lying on the east side of the river between Sioux City and Yank- , S. Dak., which had been left out of the survey of the previous year.

party was sent out in July to duplicate the primary level line between Sioux City Chamberlain, S. Dak.

small survey party was started from Chamberlain to complete the 20 miles of r next above Chamberlain left unfinished in 1892 and to make borings across the nnel of the river to find if ledge rock existed in any of the crossings or shoal es near enough the surface of low water to interfere with a project of obtaining foot channel.

t the end of the season of 1893 the field work was finished.

COMPOSITION OF PARTIES.

s used on the Missouri River survey a primary level party consists of an instru- nt man, two rodmen, an umbrella man, a teamster with team, a boatman, and cook. umbrella man is furnished with a large and strong sun umbrella to screen the rument from the wind and sun during an observation, the teamster and boat- n transport and set the bench marks in advance of the party, they sleep, eat, and k in tents that are carried along by the team and set up at the end of each day's k. Part of the time this party has moved with the regular survey party, to be

described later. When this is the case the transportation and commissary service is omitted from its organization. The instruments used are ordinary Y levels.

A river survey party consists of an assistant engineer in charge, 3 topographic parties, 1 ordinary level party, 2 tertiary triangulation parties, and a sounding party. Each topographic party is made up of 1 transit man, 1 plotter, 1 recorder, and 2 rodmen.

The level party consists of the instrument man and two rodmen, and is distinct from the primary level parties.

The triangulation parties have each a transit man and recorder.

The sounding party consists of a steersman, a recorder, two oarsmen, and a leadsman.

In addition to the foregoing, two boatmen, to navigate the quarter boats, a cook, and a second cook are required to complete the party. The quarter boats on this survey, two in number for each survey party, consist of two barges, one 65 and the other 40 feet long, with houses built on them. When moving down the river they are lashed together and float with the current, the two boatmen using long sweeps at either end to keep them off the sand bars and as near as possible in the channel of the river.

The three topographic parties are distributed as follows: One takes the shore lines, bars of the river, and adjacent topography on the bottom lands, back to the foot of the bluffs on both sides of the river, carrying the levels by stadia distance and vertical angles; the other two get the bluffs on either side with similar levels. The first-named party usually runs a line along the shore of the river, locating the stations on the banks or bars, as is most convenient, in order to obtain the topography adjacent, and also locating the sounding stations for that party.

The bluff topographers usually run their line along the first bench next to the bottom land, so that they may get the bottom at the foot of the bluff and also the hills farther back.

The level party runs the line with a Y level along the river to obtain its slope; this party also leaves temporary bench marks along by shore to enable the shore-line topographer to check his levels, carried along by stadia distance and vertical angle. This level party connects with all the permanent bench marks established by the primary party.

The triangulation parties, two in number, read the angles at the stations along the bluffs, each taking one side of the river.

Each party also furnishes correct azimuths to the topographic party on the same side, since the topographer, running over so many and short courses, is liable to get out of azimuth.

The method of sounding adopted is to run lines across the river normal to the current as nearly as possible, and then a diagonal line to the next sounding station, located about 600 feet below and on the opposite side of the river, then from this last point another line normal to the current, then a diagonal as before, and so on.

SECONDARY TRIANGULATION.

The secondary triangulation had been completed from Fort Benton to Trover Point in 1885, and in 1889 was extended to Sioux City. The lines of this triangulation were from 3 to 10 miles long, the short sides of the quadrilateral not usually being more than from 3 to 6 miles, making it an admirable system upon which to base a tertiary triangulation to verify the accuracy of the topographic and hydrographic points.

It was intended that the tertiary triangulation should determine the length of one line in each quadrilateral of the secondary work. This intention was, as a rule, adhered to, but not in all cases, for often it was found impossible to get a well-conditioned triangle to reach the line in question.

TERTIARY TRIANGULATION.

The angles of this triangulation were read with Gurley instruments having 6-inch limbs and reading by a vernier to single minutes; half minutes could, however, be easily estimated, and even quarters by particularly confident observers. They were read in series without repetition, the first series being read with instrument set in azimuth and the second and third with the instrument set 60° and 120° respectively out of azimuth. In the first series readings were taken to every station in sight up and down the river, but in the second and third only to stations coming in the immediate triangles. The mean of the three measurements obtained by the foregoing method, combined in a triangle with the means of the other two angles similarly obtained, were required to close it within one minute; although a great majority of the triangles closed within a thirty-second limit, there were a few that approached and even slightly exceeded one minute. This minute limit is large for even this class of triangulation, yet checks were made so frequently on secondary lines that it proved sufficiently small.

ngths of the lines of the tertiary triangulation were from one-half mile to 3
ng, rarely approaching either limit, the great majority being from 1 to 2 miles
consecutive stations on the same side of the river. An effort was made to
e lines 1½ miles long, this being considered about the distances that stadia
ould be depended upon to agree reasonably closely with the triangulation.
ollowing list of percentages of discrepancy is given as an example of the
y with which this work was done. During the season of 1890 there were
ned the lengths of 32 secondary lines with the following results:

xact to 5 places of logarithms.	One is in error 1 in 3,000.
e in error 1 in 40,000.	Five are in error 1 in 2,000.
in error 1 in 10,000.	Three are in error 1 in 1,800.
re in error 1 in 8,000.	One is in error 1 in 1,500.
e in error 1 in 7,000.	One is in error 1 in 1,200.
e in error 1 in 5,000.	One is in error 1 in 1,000.
e in error 1 in 4,500.	One is in error 1 in 800.
re in error 1 in 4,000.	

en the largest of these discrepancies could scarcely be shown between the
ely determined geographical positions (secondary stations) on the scale of
rts, the foregoing figures are satisfactory.

LEVELS.

plicate line of primary levels were run down the valley of the Missouri over
ire distance from Fort Benton, Mont., to Sionx City. Permanent bench
were established at proper locations at intervals of from 3 to 5 miles by the
party; they consist of flat stones buried in the ground below the frost line,
nted by iron pipes projecting above the surface. This line, in addition to
ng an accurate difference of level at points along the river, serves as a base
from for the less accurate ordinary levels which follow in connection with
eral survey party heretofore mentioned.

TOPOGRAPHY.

opographer starts his work at a triangulation station, his instrument, read-
azimuth, being set on some line the azimuth of which is known. True
is preserved throughout the work, the instrument being oriented at each
tation in the usual manner, viz, the reading of vernier A being made to dif-
from the observed azimuth of the stadia station as read from the last sta-
upied.

opographic sheets are platted and sketched in the field on protractor sheets 20
ches on a scale of 1 inch = 600 feet or $\frac{1}{7200}$, this being the scale used in making
l charts, so the former may be transferred to the latter without reduction.
tting is done by polar coordinates directly from notes obtained, and a sta-
ion is not left until a complete sketch has been made of its vicinity. This
was considered better than making the sketch in a notebook to be platted
afterwards, perhaps by a person unacquainted with the appearance of the

the topographer has completed a field sheet he turns it in to the chief of the
nd the distances between triangulation stations (of which there are usually
four) on the sheet are carefully measured, the azimuths taken graphically
e sheet, and both are compared with the computed distances and azimuths
d by the triangulation.

ops of the high hills are usually obtained by intersecting angles from three
stadia stations, the distance thus obtained between such stations and the
ing measured from the sheet graphically, and their elevation obtained by
ation from the distances and the corresponding vertical angles. For simply-
his computation tables of natural tangents printed on cards were furnished
ographical parties to carry with them in the field.

opographer was instructed to occupy all triangulation stations near his lines,
check his azimuth by comparing it with any azimuth he may have taken to
tion from other stations previously occupied. It is almost impossible for an
and careful man to make a mistake and not know it in running topography
luffs of the Missouri River, for the country is so free of trees and brush that
ome prominent object in view all the time.

tadia distances are read in feet and the difference of level between points
ed by three methods—first, by Noble and Casgrain's tables; second, by a slide
ird, by the use of a table of natural tangents.

rst and third methods were used exclusively during the season of 1889 and
e first where regularly read stadia distances and vertical angles were obtained,

and the third where points were determined by intersecting angles and the horizontal distances measured from the sheet. In the spring of 1881 the slide scale was introduced by Topographer R. G. Doerfling, who had used it previously on work in Germany. In 1891, 1892, and 1893 this device was used exclusively, in preference to the tables, as it was found to give very accurate results, with great saving in time.

The accuracy of the stadia readings varies with the clearness of the atmosphere. Some days a person can plainly discern a 5-foot interval on the stadia rod for a distance of 2,000 feet, while on other days the same mark is less distinct at 1,000 feet. So the observer must use his judgment in the distances he places his stations apart.

To test the accuracy of the work a series of 8 long courses were chained carefully and then read with the stadia. The distances chained and the corresponding stadia readings were as follows:

	Feet.		Feet.
First chained distance	1,400	Fifth chained distance	1,823
Stadia distance	1,405	Stadia distance	1,820
Second chained distance	1,420	Sixth chained distance	1,922
Stadia distance	1,420	Stadia distance	1,915
Third chained distance	1,676	Seventh chained distance	2,221
Stadia distance	1,675	Stadia distance	2,215
Fourth chained distance	1,688	Eighth chained distance	2,500
Stadia distance	1,690	Stadia distance	2,490

We find in the foregoing experiments that 4, or just one-half, of the distances read by stadia were not read to the nearest 5-foot mark, but in all but one—viz, the 1,400 foot distance—the distances were extremely long, and a slight deflection from the perpendicular in holding the rod may have caused the erroneous reading.

If the stadia work is done with an error of $\frac{1}{100}$th and the triangulation stations are not more than 2 miles apart an error of only 35 feet will accumulate, which is easily distributed, so that no appreciable difference will appear between such a survey and one that comes out exactly with the triangulation.

The sliding scale used in taking elevations from known distances and vertical angles is shown on the accompanying drawing.

In construction it is simply a representation of the logarithms by scale to allow them to be added mechanically.

The two divisions A and D on the main body of the scale represent the logarithms of numbers 1–10–100–1,000–10,000, etc. The upper division B on the movable slide represents the logarithms of $\frac{1}{2}\sin 2\measuredangle$ up to 45°, and the lower division C on the slide represents the logarithms of $\cos^2\measuredangle$ up to 45°. The line with the two arrows is the index, which is placed at 0° of division C and must point to 5° 46′ on division B because $\frac{1}{2}\sin 2(5° 46') = 0.1$. The index 0′ is to be used when the slide is pulled out so far as to bring the first index outside of the divisions A and D.

The instrument may be used to obtain differences in level from the observed vertical angles combined either with the observed stadia reading or the horizontal distance scaled from the plat.

In the first case the lower arrowhead of the index 0 is placed opposite the number in division D which corresponds to the observed stadia reading. Then the degree in division B, which corresponds to the observed vertical angle, will indicate the correct elevation on division A; thus, if the stadia reading be 150 feet and the elevation 15°, the slide should be moved until the index 0 lies opposite the number 150 in division D, as shown in the figure. Then the 15° mark of division B will indicate the correct difference in level, viz, 37.5 feet on division A.

If the index 0′ be used it should be placed opposite the stadia reading divided by 10, in division D.

In the second case, where the elements are the vertical angle and horizontal distance, the degree indicating the angle on division C should be placed opposite the horizontal distance on division D; the degree of the angle on division B will then indicate the difference in level on division A.

Thus the setting in the figure corresponds to an observed vertical angle of 15° and a horizontal distance of 140 feet, and gives the difference in level as 37.5 feet.

Should the distance be so large as not to be found on the scale, it may be divided by 10; the corresponding difference in elevation will be the tenth part of the true difference.

OFFICE WORK.

The work in the field usually closes about November 1, when the parties are ordered in, and such of the assistants as are good platters or ready computers are retained to help in mapping the survey, and the remainder discharged.

COMPUTATIONS.

The field work for the secondary triangulation was done in 1885 and 1889 by the ssouri River Commission, and the computations made at its office and published in reports to the Chief of Engineers for 1887 and 1891. Consequently secondary ses and azimuths are available for the tertiary triangulation. In the former sys- n the angles were very accurately measured, 85 per cent of the triangles closing thin the primary limit of 3 seconds; the angles were adjusted by the method of st squares; the latitudes, longitudes, and azimuths were computed from the usual mulæ.

Although computations of the tertiary triangulation are made in the field, the e there is too limited to do more than determine the lengths of the lines to check stadia work, so the triangles are all recomputed in the office and the coordinates each station obtained.

Commencing with a secondary line as a base the tertiary triangles are computed the next line connected with in the former system, when a comparison is made, l the discrepancy, when large enough to show in platting is adjusted by adding to subtracting from the base of each triangle of the series an equal amount; for mple, should the discrepancy be 20 in five places of logarithms and the mber of triangles in the series between the two secondary lines be 10, then 2 uld be added or subtracted in each consecutive base, so that when the second- line is reached the two determinations will agree. This is a rather crude thod of adjustment, but about the only one, as the large number of triangles pre- de the more laborious and accurate method. It will be seen that the foregoing ustment is made entirely in distance, because there is scarcely an instance in this ole survey where the error in azimuth between secondary lines amounts to more n a single minute.

After the triangles have been adjusted as described, the coordinates are computed be platted on the detail charts from the local azimuth of the center of each chart. is gives a minimum discrepancy in the geographical positions of the points platted ar the ends of the charts, a discrepancy that always exists on charts platted on a ne projection.

After the coordinates of the triangulation have been computed, then the coordi- tes of the stadia lines are calculated between consecutive triangulation stations, ordinates thus gotten are compared with those of the latter, and if a difference sts of more than one three-hundredth, then the stadia work is adjusted to agree th the coordinates of the triangulation.

The method of adjustment usually followed is, having the percentage of error, to tribute it proportionately in each course, according to the length of the ordinate.

PLATTING.

The detail chart is platted on a plane projection by rectangular coördinates, gen- lly using a secondary triangulation station for origin. The position of one parallel d the meridian is determined directly from this origin, the latitude and longitude which is accurately known. The other parallels and meridians are then drawn rallel to these first ones at intervals of 1 minute, using the distance between the ridians on the parallel nearest the middle of the chart for the whole chart.

After the projection of a chart has been made and the coordinates of the triangu- ion and stadia points to be platted on it have been obtained and corrected, as scribed in the foregoing, they are platted and the platting is checked by scaling distances between stations on the chart and comparing it with the computed tances. This is an absolute check, as a distance is measured from each station, from three to six other stations. The field sheet is now accurately traced and nsferred in the ordinary manner. The two sheets having many points in common s an easy matter to transfer the one to the other with great precision.

The field sheets having been transferred and the chart completed in pencil it is ned over to a draftsman and he inks all the outlines, such as contours, fences, re lines, etc., after which the printer takes it and completes it by printing the ering and conventional signs of the topography. The latter is done with "Ock- on's device for use on original topographical maps," the use of which is familiar almost every one.

The survey of the Missouri River has been completed and mapped from Fort Ben- , Mont., to Sioux City, Iowa, a distance of 1,480 miles, covering 198 detail charts. The first series of 79 charts, extending from Fort Benton to the mouth of the Yel- stone River, is drawn on a scale of $\frac{1}{4800}$ and reduced in photolithographing to a le of $\frac{1}{7200}$. The next series of 119 charts, extending from the mouth of the Yel- stone to Sioux City, is drawn on a scale of $\frac{1}{7200}$, and reduced by the photolithog- her to $\frac{1}{10800}$. The first series was drawn on sheets 39 by 69 inches and reduced -third; the next series was drawn on sheets 61.3 by 34.7 inches and reduced two- hs.

The sheets placed together would make a continuous drawing 1,080 feet long.

Printed editions of 1,000 copies of each of 114 of the detail charts have been received. Of these Julius Bien & Co., of New York, have furnished 69, and the Forbes Lithograph Manufacturing Company, of Boston, have furnished 45.

A series of small scale maps are in progress, giving less details, there being no soundings platted on them and the hills being represented by hachures instead of contours; these are drawn on a scale of 1 inch = ¼ mile, or 1:31680; there will be 57 in the series when all are completed, 44 of which are already finished.

Appended is a list of the assistants who at various times have been employed in the field work and platting.

Respectfully submitted.

F. M. TOWAR,
Assistant Engineer.

List of assistant engineers, etc., employed on survey of Missouri River.

Name.	Occupation.	Years of service.	Remarks.
F. M. Towar	Assistant engineer	1890 to 1894	
H. C. Gould	do	1891 to 1894	
G. W. Wood	do	1891 to 1892	
J. F. Nutty	do	1889	In the field only.
F. W. Lightner	do	1889 to 1892	Services chiefly in the field.
M. J. Lacy	do	1889 to 1891	
C. W. Williams	do	1891 to 1894	
H. W. Kerr	Topographer	1891	In the field only.
R. G. Doerfling	do	1891 to 1894	
C. P. Williams	do	1891 to 1894	Away about six months.
W. D. Fairchild	do	1891 to 1894	
E. A. D. Parker	do	1891 to 1894	
C. G. Weyl	do	1890 to 1892	
C. A. Swift	do	1891 to 1894	
S. L. Weil	do	1891	
C. P. Brown	do	1893 and 1894	
H. L. Thurston	do	1893 and 1894	
C. M. Ayers	do	1891	
J. C. Barton	do	1892 and 1893	
William Kossak	Draftsman	1891	
O. R. Appiano	do	1891 to 1894	
A. L. Lucas	do	1892 and 1893	
F. L. Miller	do	1893 and 1894	
I. D. McKown	Leveler	1891	
Robert McKee	do	1891 and 1892	
John Wade	do	1891 to 1894	
Ludlow Maury	Platter	1891	In office only.
E. H. Lebens	do	1891	Do.
W. J. Fuerbach	do	1891	Do.
W. C. Shope	do	1891	Do.
D. E. Condon	do	1891	Do.
W. R. Journey	do	1891	Do.
S. A. Bowes	do	1891 to 1894	
R. S. Fessenden	do	1892 to 1894	
Geo. H. Banks	do	1892 to 1894	
Julius Kahn	do	1892 to 1894	
G. F. Woodmansee	do	1892 to 1894	
F. C. Sawin	do	1892 to 1894	
W. W Wertz	do	1891	
W. B. Larabee	do	1891 to 1892	
H. L. Fisher	do	1893 and 1894	
J. F. Becker	Printer	1891 to 1893	In office only.

annel distances above mouth of Missouri River for points between Sioux City and Fort Benton.

Points.	Distance.	Points.	Distance.
	Miles.		*Miles.*
ssouri River	0.0	White River	1,054.7
Paul, Minneapolis and		Peterson Creek	1,059.3
road bridge, Sioux City	805.8	Lower Brule Indian Agency	1,062.5
	806.3	American Creek	1,062.6
ot of Pearl street)	807.2	Ocoma	1,063
ry Creek	807.4	American or Cedar Island (foot)	1,065
er	810.6	Chamberlain (Ponton bridge)	1,067.5
off (head)	817.7	Old Fort Lookout	1,076
d (head)	828.5	Des Lauriens Island (foot)	1,079.6
	831.3	Crow Creek	1,079.6
(head)	835.1	Old Fort Hale	1,080.5
ding)	837.2	Elm Creek	1,081
g)	837.2	Campbell Creek	1,083.2
r Bend	853.3	Fort Thompson (mouth of Soldier Creek)	1,087.4
ower Ferry Landing)	854.3	Badger Creek	1,087.5
ver	859.7	Camel Creek	1,090.6
t-off	863.7	Fish Creek	1,093.1
pper Ferry Landing)	864.2	Cadotte Island (foot)	1,100.9
and (foot)	879.1	Chain of Rocks	1,108.8
	883.5	St. Johns Island (foot)	1,109.8
	884	Old Red Cloud Agency	1,125.8
	887.7	Medicine Creek	1,125.9
int	892.4	Old Fort Defiance	1,126.2
t of Douglas street)	897.3	Reynolds Creek	1,130.7
e	898.8	Dry Creek	1,131.4
	900.2	Dorien Island No. 1 (foot)	1,138.5
f	902.1	Cedar Creek	1,138.8
llage	917.6	Dorien Island No. 2 (foot)	1,140.5
	919.9	Loiselle Creek	1,144.6
l	923.1	Chapelle Creek	1,148.8
k	928.3	Fort Creek	1,155
oot of Oak street)	928.9	Old Fort George	1,155.2
	934.7	Rousseau	1,157.5
	935.2	Little Medicine Creek	1,157.5
er (ferry landing)	938.1	Antelope Creek	1,162.4
	938.5	Hackberry Creek	1,163.7
mboat landing)	940.2	Farm Island (foot)	1,164.9
er	941.3	La Framboise Island (foot)	1,170
hell	941.6	Ponton Bridge	1,172.3
	942.7	Bad River	1,172.4
	946.4	Fort Pierre	1,172.5
d (foot)	946.4	Marion Island (foot)	1,172.7
ek	950.5	Pierre	1,173.2
ian Agency (ferry land-		Willow Island (foot)	1,174.1
	962.5	Lost Island (foot)	1,180
an Agency (foot of east		Oahe Mission	1,186.6
	963.4	Echo Island (foot)	1,190.7
	976.9	Chantier Creek	1,191.2
	978.1	Okobojo Island (mouth of Okobojo creek)	1,197
	978.1	Fort Sully (steamboat landing)	1,196.4
d (foot)	978.6	Fort Sully (opposite post)	1,204.1
nd (foot)	984.5	Stanley Island	1,206
	986.2	Whiskey Island	1,209.2
d (foot)	988.1	Fort Bennett	1,211.8
	988.7	Mission Creek	1,214.2
	988.8	Hog and Emilie islands	1,214.5
k	993.2	Cheyenne Island	1,218
land (foot)	993.2	Little Bend P. O	1,221.2
k	994.2	Cheyenne River	1,222
	995.2	Fox Creek	1,227.1
ding (near Wheeler)	996.8	McKinzie Creek	1,227.9
	997.6	No Heart Creek	1,229.9
eek	997.9	Devils Island (foot)	1,235.2
land (foot)	998.9	Plum Island (foot)	1,240.4
it	1,003.5	Fairbank	1,240.6
	1,005.3	Bloody Run Creek	1,241.3
sland (head)	1,007.8	Stony Gulch	1,244.4
	1,009.3	Pascal Island	1,252.9
nd (foot)	1,011.2	Pascal Creek	1,256.6
ek	1,014.1	Stove Creek	1,259.3
land (foot)	1,014.8	Dolphees Island	1,260.2
sland (foot)	1,017.3	Travessey Creek	1,263.3
ek	1,019.9	Bares Necklace Creek	1,264.5
nd (foot)	1,020.7	Forest City	1,266.6
(foot)	1,030.5	Cheyenne River Indian Agency	1,266.6
	1,039.8	Old Forest City	1,268.2
(foot)	1,042.4	Little Cheyenne Creek	1,268.5
land (foot)	1,043.9	White Brant Creek	1,275
	1,053.9	Pole Creek	1,276.6

Table of channel distances above mouth of Missouri River, etc.—Continued.

Points.	Distance.	Points.	Distance.
	Miles.		*Miles.*
Stage Creek	1,280.3	Chippewa Point	1,548.6
Buffalo Skin Creek	1,282	Connors Point	1,549
Four Bears Creek	1,284.2	Fort Berthold Indian Agency	1,555
Steamboat Creek	1,285	Dancing Bear Creek	1,555
St. Stephens Mission	1,286.7	Old Fort Berthold	1,557.4
Otter Creek	1,286.8	Little Beaver Creek	1,562
Scranton	1,288.8	Sacred Heart Mission	1,577.4
Le Beau	1,290.8	Little Missouri River	1,582.4
Moreau River	1,292.8	Rising Water Creek	1,592.2
Fox Island (head)	1,302.4	Independence (Indian village)	1,595.2
Le Compte Creek	1,305.4	Shell Creek	1,600.8
Blue Blanket Island (foot)	1,305.9	Bone Point	1,602
Green Timber Creek	1,306.9	Sunday Island (foot)	1,616.4
Bellsman Creek	1,310.3	Indian Creek	1,618.9
Grand River	1,315.8	Knife River Towhead (foot)	1,623.2
Oak Creek	1,318.8	Knife River	1,634.7
Ashley Island (head)	1,321	Crow Flies High	1,637.6
Cathead Creek	1,322.6	White Earth River	1,646.3
Campbell Landing and Post-office	1,330	Beaver Creek	1,658.7
Spring Creek	1,345.2	Strawberry Island (head)	1,661
La Grace	1,345.9	Grinnells Landing	1,661.8
Kunkpapa Creek	1,350	Little Bear Island (foot)	1,664.1
Vanderbilt	1,352.3	Bear Island (foot)	1,666.9
St. Benedict Mission	1,355.5	Clark Creek	1,670.3
Eagle Feather Creek	1,356.7	Tobacco Creek	1,672.4
Blackfoot Creek	1,357.8	Spanish Point	1,678.8
Woodhawk Bend	1,362.3	Little Muddy Cut-off	1,703.5
Four Mile Creek	1,366.3	Grizzly Bluffs	1,707.1
Fort Yates (lower landing)	1,370.8	Pebble Creek	1,710.5
Long Soldier Creek	1,371.7	Old Muddy Bend	1,717
Cattail Creek	1,372.8	Little Muddy Creek	1,719.3
Fort Yates (ferry landing)	1,373	Williston	1,730.1
Winona	1,373.5	Fort Buford	1,757.4
Fort Yates (upper landing)	1,374.9	Yellowstone River	1,760.1
Battle Creek	1,377.3	Ferry	1,761.7
Porcupine Creek	1,379.2	Willow Station	1,774.5
Willow Creek	1,383	Little Muddy	1,779
Emmonsburg (mouth Beaver Creek)	1,385	Big Muddy	1,807.6
Hampton	1,394.5	Hardscrabble Creek	1,811.7
Cannonball Mission	1,396	Devils Elbow	1,816
Cannonball River	1,398.8	Shadron Creek	1,824.3
Cannonball (at ferry)	1,399.6	Water tank and pump house (Great Northern Railroad)	1,828.4
Gayton (at ferry)	1,399.6	Black Duck (Indian village)	1,834.4
Long Lake Creek	1,403.3	Deertail (Indian village)	1,844.5
Fort Rice Landing	1,404.2	Poplar Creek	1,857.7
Rockpoint	1,404.3	Redwater Creek	1,859.7
Fort Rice Creek	1,404.5	Antelope Creek	1,866.7
Old Fort Rice	1,404.7	Spreadeagle Bar	1,876.4
Livonia	1,407.4	Elk Prairie Creek	1,887.9
Glencoe	1,415	Wolf Point	1,889.4
Little Heart River	1,433.7	Wolf Creek	1,889.9
Apple Creek	1,436.9	Sand Creek	1,897.3
Sibley Island (foot)	1,438.5	Elk Creek	1,906.3
Fort Lincoln	1,444.8	Boxelder Creek	1,922.5
Heart River	1,445.6	Milk River	1,937.5
Bismarck Railroad bridge	1,450.1	Galpin Station	1,948.6
Mandan	1,452.6	Dry Fork	1,954.6
Rockhaven	1,455.1	Old Fort Peck	1,957.1
Square Butte Creek	1,457.1	Catamount Creek	1,976.7
Mountaineers Bend	1,462	Little Dry Fork	1,981.6
Norwegian Bend	1,466.1	Flint Creek	1,992.3
Wogansport	1,469.6	Anna Island (foot)	1,994.7
Mercers Landing	1,477.4	Champaign Creek	1,998.5
Pretty Point	1,481.2	Featherland Island (foot)	1,998.5
Painted Woods Lake and Creek	1,486.2	Hell Creek	2,003
Washburn	1,492.4	Paradise Creek	2,010.1
Mandan Lake	1,501.6	Round Butte	2,016
Fort Clark Bend	1,505.2	Timber Creek	2,017.1
Stanton	1,514.1	Gibsons Island (foot)	2,019.4
Big Knife River	1,514.5	Buffalo Shoal	2,033.4
Plenty Coal Mine	1,520.9	Seven Blackfeet Creek	2,035.6
Hancock	1,523.6	Katie Kountz Bar (foot)	2,037.4
Coal Harbor	1,531	Trover Point	2,045.1
Wolf Creek	1,533.2	Fourchette Creek	2,051.6
Snake Creek	1,533.4	Goulds Creek	2,056.2
Douglas Creek	1,533	Elk Island (head)	2,065.2
Old Fort Stevenson	1,538.9	Hornet Island (foot)	2,072
Emmanuel Creek	1,544.2	Squaw Creek	
Emmanuel Rock	1,546.2		

of channel distances above mouth of Missouri River, etc.—Continued.

Points.	Distance.	Points.	Distance.
	Miles.		*Miles.*
River	2,075.8	Drowned Man Rapids	2,199.2
sland (foot)	2,076.2	Arrow River	2,206.6
ead)	2,074.7	Wolf Island (foot)	2,209.5
l (head)	2,077.8	Pablos Rapids	2,211.2
d (cut-off)	2,095.9	Dark Butte	2,214.4
ttle Company	2,099.3	Steamboat Rock	2,215.4
y (mouth of creek)	2,101.4	Hole in the Wall	2,220.5
head)	2,106.2	Cathedral Rock	2,222.5
	2,113.1	Eagle Rock (head of Kipps Rapids)	2,224.8
Wilder P. O.)	2,119.9	Castle Rock	2,227.4
	2,121.7	La Barges Rock	2,228.5
anding	2,123.2	Eagle Creek	2,228.8
Creek	2,125.7	Haystack Butte	2,233.6
(foot)	2,131.4	Iron Butte	2,233.6
	2,133.5	Sandy Creek	2,237.8
	2,135.6	Pugsley Bros. Ranch	2,240.4
nd (head)	2,139.7	Coalbanks Landing	2,242.8
and (foot)	2,142.5	Blankenbakers Ranch	2,243.7
(head)	2,144.3	Shanks Ranch (foot of Boggs Island)	2,246.7
oot)	2,155.5	Crow Couleé Bar (foot)	2,252.2
	2,156.8	Crow Creek	2,252.6
	2,157	Prices Ranch	2,253.9
	2,161.3	Three Islands (foot)	2,254.6
nd (head)	2,165.1	C. Lippards Ranch	2,256.4
	2,169	Churchills Ranch	2,257.9
apids	2,172.5	Archers Island (foot)	2,259,7
pids	2,174.6	Archers Ranch	2,260.8
r	2,180.1	Marias River	2,262.9
ids	2,181.6	Black Bluff Rapids	2,265.5
ck	2,182.7	Rowes Bayou (foot)	2,266.8
ds	2,187	Churchills Ranch	2,267.7
	2,187.3	Senieurs Reach	2,269.3
nd (head)	2,189.9	W. Rowes Ranch	2,269.8
il Island (foot)	2,191.5	Brule Bar (foot)	2,270.5
	2,192.7	J. Rowes Ranch (Fontanelle Bar)	2,272.1
oot)	2,192.9	O'Hanlons Ranch	2,274.9
d (head)	2,193.7	Crocondunez Bar	2,275.7
nch	2,194	Lippards Ranch	2,277.7
	2,195.2	Evans Ranch	2,278.4
	2,196	Shonkin Bar	2,280.7
	2,196.6	Bakers Bar	2,281.9
	2,197	Fort Benton	2,284.8
get	2,197.6		

*nd geographical positions of bench marks, primary leveling, 1885–1893, For Benton, Mont., to Sioux City, Iowa.**

um plane is approximately 71.773 feet below mean gulf level at Biloxi, Miss.]

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
	2,632.228	2,704.001	47	48	45.31	110	39	47.28
	2,628.227	2,700	47	48	59.31	110	40	09.06
	2,620.576	2,692.349	47	49	35.65	110	37	51.60
	2,621.459	2,693.232	47	49	58.29	110	38	12.74
	2,619.131	2,690.904	47	50	25.10	110	35	46.13
	2,610.020	2,681.793	47	50	53.61	110	35	58.08
	2,608.043	2,679.816	47	51	53.92	110	35	02.79
	2,619.812	2,691.585	47	51	47.27	110	35	41.02
	2,596.229	2,668.002	47	51	35.03	110	33	24.24
	2,604.981	2,676.754	47	51	51.86	110	33	07.20

ns of the benches were determined from the tertiary triangulation in connection with y of the river survey, based upon a secondary triangulation between river bluffs.
ns of the benches were determined by a duplicated line of primary levels, checked by evels of the topographic party.
from $\frac{1}{4}$ to $\frac{7}{8}$ were placed in 1885, and their positions and elevations determined in 1889 those from $\frac{1}{7}$ to $\frac{4}{7}$ placed in September and October, 1890, under the direction of the Mis- ommission.
from $\frac{4}{7}$ near Wolfpoint, Mont., to $\frac{137}{}$, near Cannonball, N. Dak., were placed and their elevations determined in June to November, 1891, and in April and May, 1892. The $\frac{138}{}$ to $\frac{202}{}$ were placed from May to October 1892, and their positions determined during he leveling to these bench marks was completed in November, 1893.

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
1	2,586.111	2,657.884	47	52	21.45	110	29	50.45
2	2,588.048	2,659.821	47	52	29.91	110	30	18.62
3	2,580.786	2,652.559	47	53	11.76	110	27	30.61
4	2,581.539	2,653.312	47	53	26.96	110	27	53.59
5	2,572.872	2,644.647	47	54	43.05	110	29	10.59
6	2,567.404	2,639.177	47	54	28.03	110	29	17.62
7	2,565.189	2,636.962	47	55	53.45	110	27	57.34
8	2,566.535	2,638.308	47	56	03.86	110	28	33.84
9	2,561.358	2,633.131	47	56	53.03	110	25	17.53
10	2,569.429	2,641.202	47	57	07.80	110	25	42.19
11	2,548.268	2,620.041	47	56	47.46	110	23	41.40
12	2,557.053	2,628.826	47	57	07.15	110	23	20.13
13	2,551.994	2,623.767	47	57	48.32	110	22	04.57
14	2,545.212	2,616.985	47	57	50.96	110	22	30.30
15	2,543.976	2,615.749	47	59	04.43	110	21	05.00
16	2,541.309	2,613.082						
17	2,554.047	2,625.820	47	58	58.54	110	19	21.70
18	2,552.790	2,624.563	47	59	24.97	110	19	22.37
19	2,538.737	2,610.510	48	00	25.64	110	18	44.88
20	2,533.781	2,605.554	48	00	20.76	110	19	07.57
21	2,531.089	2,602.862	48	01	03.54	110	17	10.26
22	2,532.573	2,604.346	48	01	13.54	110	17	03.87
23	2,531.876	2,603.649	48	01	18.83	110	13	46.78
24	2,530.132	2,601.905	48	01	44.56	110	14	12.29
25	2,523.244	2,595.017	48	02	16.42	110	10	00.61
26	2,516.277	2,588.050	48	02	37.16	110	10	08.43
27	2,508.822	2,580.595	48	00	52.81	110	07	32.07
28	2,509.109	2,580.882	48	00	54.65	110	07	03.89
29	2,513.342	2,585.115	47	57	49.29	110	05	48.70
30	2,523.908	2,595.681	47	57	58.93	110	05	20.31
31	2,497.994	2,569.767	47	55	12.31	110	03	21.24
32	2,501.436	2,573.209	47	55	13.24	110	03	08.10
33	2,513.773	2,585.546	47	53	17.27	110	03	50.07
34	2,509.705	2,581.478	47	53	16.30	110	03	35.25
35	2,495.846	2,567.619	47	51	51.94	110	04	02.51
36	2,507.955	2,579.728	47	51	42.74	110	03	44.43
37	2,497.279	2,569.052	47	50	07.70	110	04	29.08
38	2,493.909	2,565.682	47	50	07.21	110	04	14.19
39	2,488.798	2,560.571	47	48	58.53	110	02	45.89
40	2,499.677	2,571.450	47	49	09.60	110	02	38.71
41	2,483.996	2,555.769	47	47	42.25	109	59	17.97
42	2,470.518	2,542.301	47	47	46.68	109	59	05.33
43	2,471.617	2,543.390	47	46	19.10	109	58	27.75
44	2,469.951	2,541.724	47	46	26.58	109	58	17.34
45	2,461.239	2,533.012	47	45	38.21	109	53	26.95
46	2,474.092	2,545.865	47	45	42.20	109	53	09.14
47	2,461.154	2,532.927	47	43	22.82	109	51	50.49
48	2,449.452	2,521.225	47	43	27.65	109	51	38.94
49	2,442.844	2,514.617	47	42	40.04	109	47	56.53
50	2,445.917	2,517.690	47	42	47.21	109	48	02.54
51	2,435.287	2,507.060	47	42	20.38	109	45	34.37
52	2,452.120	2,523.893	47	42	27.41	109	45	27.77
53	2,439.402	2,511.175	47	43	47.73	109	41	49.55
54	2,451.132	2,522.905	47	42	55.76	109	42	06.74
55	2,416.506	2,488.279	47	44	03.92	109	38	06.27
56	2,417.168	2,488.941	47	44	16.83	109	38	51.86
57	2,429.376	2,501.149	47	44	33.74	109	35	09.21
58	2,429.301	2,501.074	47	45	01.49	109	35	09.89
59	2,407.370	2,479.143	47	44	24.37	109	33	02.51
60	2,399.757	2,471.530	47	44	33.29	109	32	57.48
61	2,408.638	2,480.411	47	44	32.31	109	30	50.45
62	2,391.948	2,463.721	47	44	44.79	109	30	43.39
63	2,408.734	2,480.507	47	43	44.60	109	28	27.95
64	2,401.078	2,472.851	47	43	53.20	109	28	30.65
65	2,395.952	2,467.725	47	43	13.34	109	24	43.39
66	2,393.532	2,465.305	47	43	24.33	109	24	53.30
67	2,414.472	2,486.245	47	44	27.95	109	22	09.16
68	2,372.965	2,444.738	47	44	36.49	109	22	13.17
69	2,373.373	2,445.146	47	46	04.06	109	17	54.43
70	2,373.587	2,445.360	47	46	09.99	109	18	05.65
71	2,348.783	2,420.556	47	47	28.19	109	14	40.69
72	2,357.651	2,429.424	47	47	38.55	109	14	40.69
73	2,356.932	2,428.705	47	47	17.56	109	11	12.73
74	2,348.566	2,420.339	47	47	27.01	109	11	07.60
75	2,334.166	2,405.939	47	47	05.78	109	06	37.21
76	2,346.654	2,418.427	47	47	17.98	109	06	50.37
77	2,343.540	2,415.313	47	47	47.42	109	03	46.09
78	2,325.793	2,397.566	47	48	00.36	109	03	36.23

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
	2,326.642	2,393.415	47	47	52.78	109	00	50.32
	2,322.747	2,394.520	47	48	01.09	109	01	01.50
	2,336.132	2,407.905	47	47	24.68	108	56	45.72
	2,308.072	2,379.845	47	47	37.25	108	56	44.09
	2,311.635	2,383.408	47	45	32.67	108	55	27.62
	2,314.260	2,386.033	47	45	40.09	108	55	10.59
	2,294.031	2,365.804	47	44	00.95	108	54	27.29
	2,319.665	2,391.438	47	44	18.16	108	54	25.11
	2,298.066	2,369.839	47	43	04.52	108	50	40.13
	2,310.706	2,382.479	47	43	21.94	108	50	30.47
	2,308.691	2,380.464	47	41	56.44	108	48	50.99
	2,298.019	2,369.792	47	42	08.53	108	48	28.19
	2,331.314	2,403.087	47	40	15.70	108	47	21.00
	2,295.247	2,367.020	47	40	19.71	108	46	35.90
	2,281.731	2,358.504	47	38	31.50	108	45	26.68
	2,275.121	2,346.894						
	2,325.359	2,397.132	47	38	04.99	108	42	58.02
	2,277.044	2,348.817	47	38	40.52	108	42	48.45
	2,274.554	2,346.327	47	37	07.12	108	40	39.45
	2,283.266	2,355.039	47	37	39.28	108	40	34.93
	2,288.666	2,360.439	47	37	18.91	108	36	34.40
	2,279.108	2,350.881	47	37	39.07	108	36	25.38
	2,257.041	2,328.814	47	36	41.51	108	32	02.19
	2,269.430	2,341.203	47	37	12.90	108	32	02.24
	2,275.153	2,346.926	47	35	52.45	108	28	10.57
	2,255.921	2,327.694	47	36	51.98	108	27	45.32
	2,280.170	2,351.943	47	34	50.74	108	24	38.94
	2,276.833	2,348.606	47	35	47.98	108	24	25.33
	2,279.100	2,350.873	47	34	24.25	108	22	31.31
	2,251.194	2,322.967	47	35	13.80	108	21	55.44
	2,234.404	2,306.177	47	34	54.52	108	19	31.21
	2,259.026	2,330.799	47	35	10.51	108	19	14.91
	2,243.876	2,315.649	47	34	39.27	108	15	51.96
	2,259.507	2,331.280	47	35	12.78	108	16	00.10
	2,227.951	2,299.724	47	35	12.24	108	11	45.88
	2,250.884	2,322.657	47	35	24.39	108	11	39.73
	2,239.036	2,310.799						
	2,234.606	2,306.379	47	35	27.97	108	08	33.54
	2,243.074	2,314.847	47	35	22.31	108	05	40.40
	2,256.204	2,327.977	47	36	00.49	108	05	16.70
	2,244.308	2,316.081	47	34	48.34	108	01	31.16
	2,217.871	2,289.644	47	35	17.81	108	01	23.78
	2,282.837	2,354.610	47	34	12.56	107	58	04.33
	2,219.174	2,290.947	47	34	44.65	107	57	23.05
	2,220.298	2,292.071	47	32	11.27	107	55	44.92
	2,214.939	2,286.712	47	32	19.77	107	54	51.02
	2,229.884	2,301.657	47	29	32.57	107	54	26.34
	2,214.496	2,286.269	47	29	44.39	107	53	40.62
	2,212.208	2,283.981	47	27	14.60	107	54	46.06
	2,204.608	2,276.381	47	27	25.17	107	54	13.65
	2,199.277	2,271.050	47	28	11.84	107	51	18.76
	2,221.231	2,293.004	47	28	07.33	107	52	08.38
	2,189.468	2,261.241	47	30	22.67	107	51	33.89
	2,201.578	2,273.351	47	30	17.14	107	52	13.79
	2,200.988	2,272.761	47	31	33.35	107	49	55.67
	2,215.687	2,287.460	47	32	00.74	107	50	32.01
	2,191.058	2,262.831	47	32	27.85	107	47	33.67
	2,201.834	2,273.607	47	33	19.85	107	47	39.95
	2,188.864	2,260.637	47	34	19.71	107	44	56.09
	2,205.330	2,277.103						
	2,174.339	2,246.112						
	2,184.776	2,256.549	47	37	02.80	107	39	47.17
	2,174.416	2,246.189	47	38	08.71	107	39	54.73
	2,189.076	2,260.849	47	38	19.70	107	31	47.66
	2,166.903	2,238.676	47	38	38.88	107	31	30.65
	2,164.086	2,235.859	47	38	52.40	107	25	48.43
	2,182.500	2,254.273	47	39	04.82	107	26	07.39
	2,154.658	2,226.431	47	40	31.58	107	16	41.07
	2,169.188	2,240.961	47	40	46.61	107	16	27.09
	2,165.587	2,237.360	47	39	27.53	107	02	18.50
	2,147.790	2,219.563	47	39	53.20	107	02	49.88
	2,150.204	2,221.977	47	42	13.31	106	52	00.00
	2,119.414	2,191.187	47	42	25.32	106	52	47.56
	2,144.938	2,216.711	47	43	34.19	106	45	18.13
	2,105.543	2,177.316	47	43	58.61	106	45	03.66
	2,113.313	2,185.086	47	45	52.36	106	40	34.52
	2,113.778	2,185.551	47	46	57.98	106	41	09.13
	2,135.739	2,207.512	47	46	44.26	106	36	09.42

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
84	2,124.522	2,196.295	47	48	34.01	106	36	40.11
85	2,092.222	2,163.995	47	51	14.78	106	31	28.13
86	2,099.522	2,171.295	47	52	14.29	106	32	51.13
86	2,099.888	2,171.661	47	54	41.51	106	29	28.49
80	2,072.861	2,144.634	47	54	41.59	106	31	31.51
87	2,063.769	2,135.542	47	57	42.26	106	27	36.67
87	2,112.771	2,184.544	47	58	55.56	106	27	13.14
88	2,121.061	2,192.834	47	58	14.32	106	24	24.24
89	2,116.887	2,188.660	48	01	52.50	106	25	01.74
89	2,055.456	2,127.229	48	02	00.33	106	26	07.20
90	2,091.869	2,163.642	48	02	30.60	106	21	14.52
91	2,115.955	2,187.728	48	01	57.91	106	15	42.51
91	2,037.824	2,109.597	48	02	37.75	106	15	19.25
92	2,083.824	2,155.597	48	00	35.66	106	09	23.06
93	2,067.145	2,138.918	48	02	03.41	106	07	33.38
93	2,021.028	2,092.801	48	00	06.48	106	02	10.97
93	2,066.285	2,138.058	48	02	04.41	106	00	56.05
94	2,055.549	2,127.322	48	00	03.39	105	55	15.05
94	2,008.319	2,080.092	48	01	27.98	105	53	30.08
95	2,003.244	2,075.017	48	01	12.99	105	47	14.23
96	1,999.120	2,070.893	48	03	09.19	105	46	55.37
80	2,004.683	2,076.456	48	01	43.52	105	42	58.03
96	1,995.623	2,067.396	48	03	38.17	105	41	40.04
97	2,044.553	2,116.326	48	02	34.66	105	39	33.21
97	1,999.741	2,071.514	48	04	37.18	105	38	36.72
98	1,985.741	2,057.514	48	05	55.17	105	35	05.33
99	1,981.423	2,053.196	48	06	30.68	105	30	43.14
100	1,976.457	2,048.230	48	07	00.97	105	26	45.30
101	1,978.453	2,050.226	48	07	12.96	105	22	45.05
102	1,969.828	2,041.601	48	07	46.55	105	19	06.75
103	1,964.237	2,036.010	48	07	06.19	105	15	35.96
104	1,993.242	2,065.015	48	06	30.88	105	11	42.50
105	1,960.504	2,032.277	48	06	20.23	105	08	23.08
106	2,007.987	2,079.760	48	05	32.02	105	04	20.45
107	1,989.467	2,061.240	48	05	50.26	104	59	59.40
108	1,984.143	2,055.916	48	07	39.62	104	56	49.49
109	1,960.072	2,031.845	48	09	09.67	104	53	49.59
110	1,932.583	2,004.356	48	08	58.07	104	50	03.87
111	1,946.730	2,018.503	48	08	29.30	104	45	33.35
112	1,946.481	2,018.254	48	08	50.40	104	41	25.35
113	1,923.564	1,995.337	48	08	43.81	104	37	07.90
114	1,918.977	1,990.750	48	08	07.45	104	33	15.23
115	1,925.345	1,997.118	48	07	38.98	104	29	37.96
116	1,929.902	2,001.675	48	06	36.33	104	26	14.94
117	1,923.195	1,994.968	48	04	21.10	104	21	43.53
118	1,923.974	1,995.747	48	03	13.88	104	17	31.98
119	1,925.369	1,997.142	48	02	38.95	104	14	01.13
120	1,905.693	1,977.466	48	04	38.83	104	11	04.67
121	1,906.795	1,978.568	48	03	35.93	104	07	51.35
122	1,897.769	1,969.542	48	01	45.81	104	05	16.10
123	1,907.403	1,979.176	48	00	07.92	104	02	42.07
124	1,899.626	1,971.399	47	59	02.48	104	00	02.24
Buford gauge	1,881.610	1,953.383						
125	1,908.659	1,980.432	48	00	05.18	103	55	56.88
126	1,899.421	1,971.194	48	01	53.78	103	52	28.91
127	1,910.431	1,982.204	48	04	05.32	103	50	20.60
128	1,888.555	1,960.328	48	05	01.48	103	46	50.11
129	1,865.703	1,937.476	48	06	29.31	103	43	11.26
130	1,896.076	1,967.849	48	08	08.01	103	40	54.17
131	1,871.362	1,943.135	48	08	34.88	103	37	06.27
132	1,876.701	1,948.474	48	07	29.34	103	33	30.47
133	1,865.476	1,937.249	48	05	03.95	103	32	42.17
134	1,860.531	1,932.304	48	03	03.36	103	32	24.37
135	1,892.693	1,964.466	48	01	35.11	103	28	55.49
136	1,845.773	1,917.546	48	02	49.70	103	24	36.23
137	1,854.857	1,926.630	48	03	33.80	103	20	46.17
138	1,848.745	1,920.518	48	03	30.08	103	17	08.07
139	1,858.872	1,930.645	48	06	02.36	103	14	48.50
140	1,829.408	1,901.181	48	08	27.20	103	11	47.98
141	1,832.276	1,904.049	48	09	29.45	103	07	51.49
142	1,815.404	1,887.177	48	08	56.42	103	03	43.17
143	1,831.453	1,903.226	48	08	42.30	102	59	03.90
144	1,990.058	2,061.831	48	06	40.94	102	56	43.53
145	1,875.948	1,947.721	48	07	07.23	102	49	47.75
146	1,820.495	1,892.268						
146	1,896.300	1,968.073	48	06	01.89	102	40	52.56
147	1,867.984	1,939.751	48	02	55.67	102	36	37.53
148	1,881.335	1,953.108	47	59	29.19	102	32	44.03
149	1,821.422	1,893.195	47	54	39.11	102	37	48.30

·ations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
.....	1,820.679	1,892.452	47	50	18.85	102	38	23.17
.....	1,813.570	1,885.343	47	47	14.37	102	31	57.52
.....	1,769.035	1,840.808	47	46	04.05	102	23	19.41
.....	1,798.965	1,870.738	47	46	58.49	102	15	23.01
.....	1,802.555	1,874.328	47	43	49.97	102	15	30.31
.....	1,777.681	1,849.454	47	40	56.18	102	13	31.46
.....	1,847.518	1,919.291	47	37	25.00	102	14	24.82
.....	1,774.343	1,846.116	47	36	06.21	102	09	35.89
.....	1,796.920	1,868.693	47	35	23.50	102	05	20.08
.....	1,762.761	1,834.534	47	33	20.84	101	59	34.40
.....	1,817.464	1,889.727	47	32	13.85	101	56	37.48
.....	1,726.154	1,797.927	47	30	21.55	101	54	32.17
.....	1,752.717	1,824.490	47	30	45.89	101	48	43.53
.....	1,761.601	1,833.374	47	32	09.76	101	44	11.05
.....	1,764.911	1,836.684	47	32	24.63	101	40	06.65
.....	1,762.226	1,833.999	47	32	58.14	101	33	07.36
.....	1,734.450	1,806.223	47	34	14.62	101	27	34.43
.....	1,746.004	1,817.777	47	33	31.46	101	23	43.01
on.....	1,930.267	2,003.040	47	32	12.06	101	21	53.01
.....	1,730.847	1,802.620	47	29	11.17	101	23	51.27
.....	1,704.488	1,776.261	47	26	13.57	101	24	36.84
.....	1,750.057	1,821.830	47	22	57.66	101	21	39.57
.....	1,748.556	1,820.329	47	19	21.32	101	20	29.53
.....	1,751.039	1,822.812	47	17	35.37	101	16	56.74
.....	1,736.020	1,807.793	47	16	08.38	101	13	57.57
.....	1,743.407	1,815.180	47	17	13.81	101	10	08.94
.....	1,705.115	1,776.888	47	17	57.52	101	04	08.41
uthwest corner Christiansen	1,740.021	1,811.794	.....			.....		
utheast corner Christiansen	1,740.145	1,811.918	.....			.....		
.....	1,746.082	1,817.855	47	16	09.25	100	59	30.79
.....	1,722.066	1,793.839	47	12	22.71	100	56	39.16
.....	1,699.423	1,771.196	47	09	35.41	100	56	51.03
.....	1,683.388	1,755.161	47	06	54.01	100	55	59.49
.....	1,716.203	1,787.976	47	03	04.51	100	52	41.54
.....	1,802.655	1,874.428	46	59	23.27	100	53	04.94
.....	1,802.748	1,874.521	46	56	59.57	100	53	53.02
.....	1,714.414	1,786.187	46	53	32.82	100	51	28.07
.....	1,658.205	1,729.978	46	52	19.31	100	53	14.68
.....	1,649.891	1,721.664	.....			.....		
.....	1,686.361	1,753.140	46	50	00.77	100	49	57.44
ge, pier No. 1	1,689.940	1,761.713	.....			.....		
·ery.....	1,674.244	1,746.017	.....			.....		
ge, pier No. 2	1,689.961	1,761.734	.....			.....		
·. Signal Corps Office.....	1,676.922	1,748.695	.....			.....		
k building	1,676.526	1,748.299	.....			.....		
t National Bank building	1,678.508	1,750.281	.....			.....		
.....	1,667.429	1,739.202	46	48	19.37	100	48	31.02
....	1,688.413	1,760.186	46	45	55.63	100	50	43.82
.....	1,727.995	1,799.768	46	42	15.82	100	49	01.82
.....	1,695.156	1,766.929	46	42	12.15	100	45	01.09
.....	1,631.208	1,702.981	46	40	42.00	100	41	57.40
.....	1,661.536	1,733.309	46	40	49.96	100	37	39.40
.....	1,718.686	1,790.459	46	37	25.15	100	39	24.45
.....	1,658.202	1,729.975	46	37	49.31	100	33	13.05
.....	1,638.718	1,710.491	46	34	41.30	100	35	34.92
.....	1,659.369	1,731.142	46	31	52.32	100	32	20.90
.....	1,646.718	1,718.491	46	30	06.98	100	35	00.52
.....	1,635.243	1,707.016	46	27	21.55	100	34	54.04
.....	1,609.913	1,681.686	46	24	50.27	100	35	39.36
.....	1,631.692	1,703.465	46	25	06.00	100	33	41.62
.....	1,662.696	1,734.469	46	22	25.90	100	34	33.62
.....	1,630.686	1,702.459	46	22	42.34	100	33	15.47
.....	1,636.604	1,708.377	46	18	46.02	100	32	21.44
.....	1,627.329	1,699.102	46	16	42.12	100	34	06.79
.....	1,620.615	1,691.388	46	14	30.83	100	33	48.85
.....	1,619.395	1,691.168	46	14	35.48	100	32	30.64
.....	1,608.382	1,680.155	46	12	11.98	100	34	37.97
.....	1,641.468	1,713.241	46	12	10.92	100	34	27.75
.....	1,594.735	1,666.508	46	09	10.19	100	36	42.56
.....	1,612.731	1,684.504	46	09	05.05	100	36	23.62
.....	1,638.477	1,710.250	46	05	27.28	100	37	34.95
.....	1,622.395	1,694.168	46	06	04.38	100	36	10.16
.....	1,602.762	1,674.535	46	01	08.81	100	33	07.12
.....	1,640.597	1,712.370	45	58	08.47	100	29	38.20
.....	1,697.024	1,768.797	45	58	44.40	100	28	57.46
.....	1,632.737	1,704.510	45	55	29.33	100	25	52.11
.....	1,654.762	1,726.535	45	55	45.33	100	25	19.31

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude		
	Feet.	*Feet.*	°	′	″	°	′	″
[illegible]	1,576.670	1,648.443	45	52	29.36	100	21	30.34
[illegible]	1,640.571	1,712.344	45	53	01.63	100	21	18.68
[illegible]	1,567.332	1,639.105	45	48	57.90	100	21	32.19
[illegible]	1,587.335	1,659.108	45	46	57.17	100	20	53.09
[illegible]	1,614.258	1,686.031	45	47	07.93	100	20	30.54
[illegible]	1,593.710	1,665.483	45	42	55.16	100	17	53.48
[illegible]	1,606.883	1,678.656	45	43	01.65	100	17	37.40
[illegible]	1,585.234	1,657.007	45	40	48.84	100	18	50.02
[illegible]	1,573.478	1,645.251						
[illegible]	1,564.976	1,636.749	45	37	25.30	100	25	06.96
[illegible]	1,615.518	1,687.291	45	37	22.29	100	24	22.01
[illegible]	1,572.910	1,644.683	45	33	50.09	100	28	40.78
[illegible]	1,568.527	1,640.300	45	33	44.44	100	27	48.02
[illegible]	1,559 645	1,631.418	45	30	20.20	100	25	58.42
[illegible]	1,552.760	1,624.523	45	30	51.10	100	26	05.22
[illegible]	1,605.883	1,677,656	45	28	47.34	100	20	22.89
[illegible]	1,604.170	1,675.943	45	28	55.78	100	19	54.20
[illegible]	1,588.059	1,660.432	45	23	25.99	100	15	43.27
[illegible]	1,648.110	1,719.883	45	23	31.40	100	15	18.89
[illegible]	1,551.288	1,623.061	45	17	57.12	100	17	57.71
[illegible]	1,543.589	1,615.362	45	18	23.46	100	17	36.51
[illegible]	1,548.087	1,619.860	45	16	44.36	100	16	34.61
[illegible]	1,549.689	1,612.462	45	13	56.53	100	14	55.24
[illegible]	1,583.085	1,654.858	45	14	02.44	100	14	21.81
[illegible]	1,558.917	1,630.690	45	10	11.86	100	16	15.02
[illegible]	1,569.972	1,641.745	45	10	06.84	100	15	50.44
[illegible]	1,581.681	1,653.454	45	06	22.86	100	18	34.51
[illegible]	1,629.178	1,700.951	45	06	19.38	100	17	56.04
[illegible]	1,519.505	1,591.278	45	03	00.60	100	17	26.59
[illegible]	1,521.133	1,592.906	45	01	32.59	100	15	21.73
[illegible]	1,527.312	1,599.085	45	01	08.39	100	18	04.10
[illegible]	1,525.727	1,597.500	45	00	43.67	100	18	05.20
[illegible]	1,518.520	1,590.293	45	00	20.55	100	24	13.46
[illegible]	1,546.203	1,617.976	45	00	11.82	100	23	52.50
[illegible]	1,500.561	1,572.334	44	58	05.04	100	24	54.50
[illegible]	1,540.595	1,612.368	44	58	04.00	100	24	27.13
[illegible]	1,498.905	1,570.678	44	52	57.51	100	23	29.20
[illegible]	1,506.215	1,577.988	44	53	09.61	100	22	51.72
[illegible]	1,514.200	1,585.973	44	49	50.60	100	26	00.97
[illegible]	1,502.905	1,574.678	44	47	24.89	100	29	50.23
[illegible]	1,565.531	1,637.304	44	47	08.54	100	29	24.36
[illegible]	1,512.061	1,583.834	44	46	02.70	100	34	46.69
[illegible]	1,522.566	1,594.339	44	45	17.92	100	35	02.77
[illegible]	1,531.014	1,602.787	44	48	25.50	100	39	41.79
[illegible]	1,484.368	1,556.141	44	47	50.00	100	43	14.31
[illegible]	1,531.534	1,603.307	44	47	45.82	100	42	37.63
[illegible]	1,471.094	1,542.867	44	44	54.33	100	46	36.75
[illegible]	1,493.014	1,564.787	44	45	08.84	100	38	18.09
[illegible]	1,489.812	1,561.585	44	40	39.76	100	36	30.14
[illegible]	1,537.510	1,609.283	44	40	34.72	100	36	20.47
[illegible]	1,489.191	1,540.964	44	37	56.79	100	37	25.86
Fort Sully, S. Dak. (window sill of pump-house)	1,460.803	1,532.576						
[illegible]	1,492.650	1,564.423	44	34	48.73	100	36	38.62
[illegible]	1,500.478	1,572.251	44	34	54.10	100	36	22.96
[illegible]	1,456.950	1,528.723	44	33	27.47	100	33	32.14
[illegible]	1,469.889	1,541.662	44	33	48.37	100	33	36.68
[illegible]	1,473.400	1,545.173	44	32	22.54	100	29	56.46
[illegible]	1,495.813	1,567.586	44	30	15.96	100	33	04.96
[illegible]	1,525.325	1,597.098	44	30	08.35	100	33	06.73
[illegible]	1,523.954	1,595.727	44	28	38.49	100	34	22.49
[illegible]	1,447.047	1,518.820	44	27	14.18	100	31	17.27
[illegible]	1,479.087	1,550.860	44	28	01.45	100	31	40.96
[illegible]	1,438.712	1,510.485	44	28	20.80	100	27	30.99
[illegible]	1,436.318	1,508.091	44	27	51.48	100	24	46.22
[illegible]	1,470.606	1,542.469	44	28	04.65	100	24	36.23
[illegible]	1,486.037	1,557.810	44	25	53.99	100	22	61.53
[illegible]	1,451.060	1,522.833	44	23	43.96	100	22	16.94
[illegible]	1,451.546	1,523.319	44	21	13.76	100	23	16.79
[illegible]	1,491.237	1,563.010	44	22	08.45	100	21	02.45
Pierre, S. Dak.—Gauge B. M.	1,432.984	1,504.757						
Pierre, S. Dak.—Corner Pierre street and Sioux avenue	1,437.854	1,509.627						
Pierre, S. Dak.—Chicago and Northwestern Railway depot	1,434.312	1,506.085						
Pierre, S. Dak.—Weather Bureau B. M.	1,441.439	1,513.212						
West base	1,428.372	1,500.145	44	21	14.97	100	19	47.76
[illegible]	1,444.124	1,515.897	44	21	08.20	100	18	22.60

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.	Longitude.
	Feet.	*Feet.*	° ′ ″	° ′ ″
.....	1,431.658	1,503.431	44 20 46.24	100 17 07.56
.....	1,441.053	1,512.826	44 20 26.05	100 14 30.27
.....	1,470.374	1,542.147	44 20 34.67	100 14 23.71
.....	1,422.904	1,494.677	44 19 47.32	100 11 37.41
.....	1,421.925	1,493.698	44 19 24.71	100 08 34.37
.....	1,425.688	1,497.461	44 19 37.81	100 08 33.52
.....	1,415.127	1,486.900	44 18 48.47	100 04 52.91
.....	1,435.286	1,507.059	44 19 10.48	100 04 50.24
.....	1,448.528	1,520.301	44 17 43.01	100 02 01.42
.....	1,432.044	1,503.817	44 16 21.35	99 59 19.84
.....	1,461.995	1,533.768	44 16 27.44	99 59 16.01
.....	1,408.937	1,480.710	44 16 09.93	99 55 47.68
.....	1,424.917	1,496.690	44 16 26.72	99 55 47.15
.....	1,448.859	1,520.632	44 14 19.80	99 53 14.79
.....	1,439.709	1,511.482	44 12 37.94	99 55 07.10
.....	1,457.107	1,528.880	44 12 33.28	99 54 59.80
.....	1,443.978	1,515.751	44 09 48.39	99 54 28.19
.....	1,403.529	1,475.302	44 07 45.16	99 52 13.45
.....	1,426.024	1,497.797	44 08 07.90	99 52 07.01
.....	1,395.873	1,467.646	44 07 50.85	99 49 46.16
.....	1,403.129	1,474.902	44 08 14.12	99 45 44.43
.....	1,444.633	1,516.406	44 08 21.19	99 45 41.40
.....	1,424.609	1,496.382	44 07 12.61	99 42 25.05
.....	1,427.448	1,499.221	44 06 13.07	99 38 51.25
.....	1,447 858	1,519.631	44 06 18.12	99 38 53.09
.....	1,392.420	1,464.193	44 07 16.42	99 36 15.22
.....	1,424.347	1,496.120	44 08 47.06	99 36 20.55
.....	1,390.925	1,462.698	44 08 30.66	99 36 48.78
.....	1,402.998	1,474.771	44 10 13.41	99 39 34.50
.....	1,406.064	1,477.837	44 11 49.85	99 41 21.88
.....	1,373.073	1,444.846	44 12 35.60	99 39 10.52
.....	1,383.702	1,455.475	44 12 44.97	99 39 10.53
.....	1,378.062	1,449.835	44 11 57.73	99 35 49.22
.....	1,369.095	1,440.868	44 09 24.06	99 33 18.05
.....	1,385.623	1,457.396	44 05 58.29	99 34 43.74
.....	1,401.877	4,473.650	44 03 58.94	99 32 50.89
.....	1,372.700	1,444.473	44 04 16.27	99 32 35.16
.....	1,381.114	1,452.887	44 02 54.74	99 29 21.90
.....	1,375.385	1,447.158	44 02 22.75	99 26 55.34
.....	1,393.462	1,465.235	44 01 03.64	99 23 36.83
.....	1,366.367	1,438.140	43 58 43.38	99 21 32.76
.....	1,395.641	1,467.414	43 56 32.89	99 22 02.49
.....	1,374.802	1,446.575	43 53 56.27	99 22 02.80
.....	1,361.607	1,433.380	43 52 08.89	99 19 08.32
.....	1,346.272	1,418.045	43 50 52.63	99 19 29.69
n, S Dak.—Chicago, Milwaukee aul Railway water tank.....	1,355.924	1,427.697	.....	.....
n, S. Dak.—Chicago, Milwaukee 'aul Railway depot.....	1,360.220	1,431.993	.....	.....
n, S. Dak., center of Main and streets.....	1,392.541	1,464.314	.....	.....
n. S. Dak., hydrant at southwest ain and Clemens streets.....	1,395.804	1,467 577	.....	.....
n, S. Dak., Taft House.....	1,415.042	1,486.815	.....	.....
n, S. Dak., high school.....	1,468.826	1,540.599	.....	.....
.....	1,454.159	1,525.932	43 48 21.20	99 19 50.11
.....	1,354.694	1,426.467	43 47 28.72	99 21 20.92
.....	1,369.193	1,440.966	43 47 17.96	99 24 51.82
.....	1,361.171	1,432.944	43 46 34.91	99 24 10.76
.....	1,349.965	1,421.738	43 44 38.18	99 24 16.63
.....	1,366.263	1,438.036	43 44 40.16	99 24 00.52
.....	1,363.641	1,435.414	43 41 53.82	99 24 23.20
.....	1,339.349	1,411.122	43 40 25.28	99 27 30.61
.....	1,330.600	1,402.463	43 39 24.36	99 25 46.58
.....	1,328.820	1,400.593	43 39 35.76	99 25 44.00
.....	1,353.067	1,424.840	43 40 00.10	99 21 56.46
.....	1,362.671	1,434.444	43 37 58.98	99 20 13.46
.....	1,363.677	1,435.450	43 35 22.60	99 19 53.53
.....	1,339.873	1,411.646	43 33 35.49	99 19 00.97
.....	1,352.743	1,424.516	43 33 43.46	99 18 46.06
.....	1,319.985	1,391.758	43 32 23.43	99 17 06.31
.....	1,334.793	1,406.566	43 29 53.62	99 17 37.41
.....	1,348.343	1,420.116	43 27 23.22	99 16 42.52
.....	1,384.865	1,456.638	43 27 33.38	99 16 23.47
.....	1,302.066	1,373.839	43 26 24.51	99 14 31.53
.....	1,320.128	1,391.901	43 26 32.43	99 10 50.89
.....	1,306.110	1,377.883	43 23 50.63	99 07 49.33
.....	1,289.918	1,361.691	43 21 18.17	99 04 58.10

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
288	1,315.110	1,386.883	43	21	21.48	99	04	54.79
289	1,304.842	1,376.615	43	19	19.01	99	03	44.74
290	1,282.294	1,354.067	43	17	32.02	99	01	34.30
291	1,311.956	1,383.729	43	17	45.58	99	01	17.20
292	1,288.440	1,360.213	43	15	54.80	98	58	50.44
293	1,279.941	1,351.714	43	14	51.06	98	54	41.11
294	1,306.550	1,378.323	43	14	59.82	98	54	34.92
295	1,311.026	1,382.799	43	13	42.60	98	51	52.62
296	1,289.029	1,360.802	43	10	11.38	98	51	47.61
297	1,269.981	1,341.754	43	09	17.33	98	50	32.40
298	1,310.814	1,382.587	43	09	35.94	98	50	24.88
299	1,269.146	1,340.919	43	08	55.69	98	46	43.28
300	1,285.062	1,356.835	43	09	14.27	98	46	37.22
301	1,287.909	1,359.682	43	07	21.29	98	44	04.81
302	1,278.365	1,350.138	43	05	23.63	98	42	13.15
303	1,251.782	1,323.555						
310	1,258.984	1,330.757	43	04	35.65	98	39	12.00
311	1,250.833	1,322.606	43	04	26.78	98	36	37.09
312	1,282.668	1,354.441	43	03	10.97	98	33	40.10
313	1,249.947	1,321.720	43	03	42.17	98	33	42.89
314	1,263.618	1,335.391	43	02	20.69	98	31	17.75
315	1,243.902	1,315.675	42	59	33.28	98	29	30.38
314	1,247.931	1,319.704	42	59	42.08	98	29	06.71
316	1,242.007	1,313.780	42	57	44.61	98	27	37.23
317	1,286.761	1,358.534	42	55	46.12	98	24	34.24
318	1,262.499	1,334.272	42	55	13.83	98	23	14.47
319	1,235.304	1,307.077	42	53	44.59	98	20	56.75
320	1,236.545	1,308.318	42	53	51.56	98	20	50.39
321	1,231.601	1,303.374	42	53	10.75	98	18	04.51
322	1,231.042	1,302.815	42	52	21.73	98	15	21.60
323	1,230.346	1,302.119	42	52	28.69	98	15	17.20
324	1,227.661	1,299.434	42	51	06.23	98	12	04.10
325	1,240.264	1,312.037	42	51	09.89	98	09	36.56
326	1,254.878	1,326.651	42	51	24.76	98	09	36.35
327	1,263.068	1,334.841	42	49	09.00	98	06	43.93
328	1,219.466	1,291.239	42	47	34.33	98	04	28.63
329	1,229.506	1,301.279	42	47	43.07	98	04	21.58
330	1,248.673	1,320.446	42	45	04.11	98	01	41.73
331	1,244.476	1,316.249	42	46	06.03	97	59	11.89
332	1,254.077	1,325.850	42	46	13.78	97	58	52.87
333	1,211.668	1,283.441	42	46	53.38	97	56	04.87
334	1,223.584	1,295.357	42	48	36.04	97	53	34.49
335	1,282.368	1,354.141	42	50	57.17	97	53	38.22
336	1,272.266	1,344.039	42	51	24.90	97	53	32.26
337	1,207.347	1,279.120	42	52	21.13	97	49	38.10
338	1,250.191	1,321.964	42	50	19.86	97	48	29.14
339	1,201.220	1,272.993	42	51	56.16	97	44	23.66
340	1,211.209	1,282.982	42	52	02.65	97	44	21.44
341	1,231.425	1,303.198	42	49	28.32	97	41	56.81
342	1,205.445	1,277.218	42	51	26.50	97	41	28.24
343	1,226.880	1,298.653	42	50	24.54	97	38	29.13
344	1,204.297	1,276.070	42	51	23.07	97	32	43.22
345	1,275.044	1,346.817	42	51	33.66	97	32	44.74
346	1,179.843	1,251.616	42	51	46.01	97	28	43.04
347	1,187.459	1,259.232	42	52	17.24	97	28	36.23
348	1,197.291	1,269.064	42	52	18.94	97	25	30.70
349	1,169.699	1,241.472	42	53	08.57	97	20	13.22
350	1,171.158	1,242.931	42	53	19.11	97	20	07.51
351	1,223.943	1,295.716	42	51	09.85	97	18	29.40
352	1,161.494	1,233.267	42	51	12.47	97	13	12.30
353	1,161.479	1,233.252	42	51	33.29	97	13	12.70
354	1,248.076	1,319.849	42	49	19.14	97	15	41.25
355	1,159.686	1,231.459	42	49	08.08	97	12	45.00
356	1,161.037	1,232.810	42	49	20.30	97	12	43.73
357	1,157.566	1,229.339	42	48	25.61	97	09	39.07
358	1,150.143	1,221.916	42	45	38.40	97	04	50.93
359	1,149.956	1,221.729	42	46	28.37	97	03	43.11
360	1,152.825	1,224.598	42	46	50.68	97	03	42.91
361	1,151.662	1,223.435	42	45	46.87	97	01	09.06
362	1,146.725	1,218.498	42	47	20.10	96	59	35.46
363	1,153.535	1,225.308	42	43	11.41	96	58	36.01
364	1,223.469	1,295.242	42	45	04.50	96	55	55.70
365	1,137.504	1,209.277	42	43	32.30	96	54	50.44
366	1,136.978	1,208.751	42	43	12.53	96	52	30.74
367	1,134.246	1,206.019	42	44	51.36	96	49	42.73
368	1,132.649	1,204.422	42	45	10.71	96	49	32.85
369	1,128.801	1,200.574	42	43	00.44	96	47	27.68
370	1,129.407	1,201.180	42	41	28.60	96	45	06.27

Elevations and geographical positions of bench marks, etc.—Continued.

Bench mark.	Elevation above gulf level at Biloxi, Miss.	Elevation above datum.	Latitude.			Longitude.		
	Feet.	*Feet.*	°	′	″	°	′	″
[illegible]	1,128.742	1,200.515	42	41	41.93	96	45	07.66
[illegible]	1,124.413	1,196.186	42	40	37.15	96	42	10.49
[illegible]	1,123.635	1,195.408	42	41	05.27	96	40	57.55
[illegible]	1,120.375	1,192.148	42	37	06.22	96	41	17.27
[illegible]	1,118.577	1,190.350	42	34	51.43	96	41	25.73
[illegible]	1,120.807	1,192.670	42	35	44.25	96	41	07.75
[illegible]	1,131.942	1,203.715	42	32	00.82	96	39	07.04
[illegible]	1,110.904	1,182.677	42	32	07.65	96	37	35.34
[illegible]	1,117.561	1,189.334	42	34	35.02	96	37	30.46
[illegible]	1,109.117	1,180.890	42	33	01.69	96	35	50.92
[illegible]	1,109.583	1,181.356	42	34	25.03	96	34	28.75
[illegible]	1,109.837	1,181.610	42	36	15.31	96	33	41.53
[illegible]	1,108.447	1,180.220	42	33	37.80	96	32	04.71
[illegible]	1,106.599	1,178.372	42	29	27.77	96	33	56.57
[illegible]	1,105.657	1,177.430	42	32	45.44	96	30	19.74
[illegible] Missouri River Commission	1,106.823	1,178.596	42	29	41.96	96	24	17.84

ESCRIPTION OF LOCATIONS OF BENCH MARKS, PRIMARY LEVELING, 1893, FROM CHAMBERLAIN, S. DAK., TO SIOUX CITY, IOWA.*

$2\frac{1}{2}^{1}$ On left bank, 2 miles below Chamberlain, one-fourth mile above foot of American Island, 250 feet below small frame house 100 feet from river.

$2\frac{1}{2}^{4}$ On left bank, opposite mouth of American Creek just below small creek. House of George Linebeck is 100 feet back of B. M.

$2\frac{1}{2}^{4}$ On right bank, 135 feet west and 55 feet south of southwest corner of agent's office at Brule Indian Agency, in southwest corner of yard.

$2\frac{1}{2}^{5}$ On left bank, on first bench, 700 feet from river and about 150 feet above Peterson Creek, 100 feet back from edge of bank.

$2\frac{1}{2}^{5}$ About one-fourth mile back of $2\frac{2}{2}^{5}$, about 400 feet above Peterson Creek, on south side of a young grove or timber claim.

$2\frac{1}{2}^{6}$ On left bank, about one-fourth mile above end of Peterson Bottom and about 50 feet from river on nose of bluffs below small wooded coulee.

$2\frac{1}{2}^{7}$ On left bank, about 2,000 feet below head of bottom, 1½ miles below White River, on edge of low broken bench land, 200 feet from foot of bluffs, about 650 feet from river.

$2\frac{1}{2}^{8}$ On left bank, about 2 miles below $2\frac{2}{2}^{7}$. On first bench, about 800 feet from river. House of David Forbes is about 500 feet northeast of B. M.

$2\frac{1}{2}^{8}$ About one-fourth mile back of $2\frac{2}{2}^{8}$ on flat prairie. Wagon road is 300 feet south of B. M. David Forbes's house is about 800 feet south of B. M.

$2\frac{1}{2}^{9}$ On left bank, about 3 miles below $2\frac{2}{2}^{8}$, about 400 feet from foot of steep bluffs on gentle slope and near corner of wire fence, just outside of inclosure. Log shack about 800 feet southeast of B. M.

$2\frac{1}{2}^{0}$ On the left bank, at end of bottom, opposite head of Gen. Brooks Island, on lower side of small coulee with single large elm tree at mouth. On bench land 250 feet from river.

$2\frac{1}{2}^{1}$ On left bank, about 3 miles below $2\frac{2}{2}^{0}$, and about 100 feet from river on nose of bluffs below small steep coulee, near foot of Sonora Island.

$2\frac{1}{2}^{2}$ On left bank, about 2½ miles below $2\frac{2}{2}^{1}$, about 400 feet below Elm Creek, on high bench land, about 150 feet from river. House and barn of La Follette's horse ranch about 1,000 feet north of B. M.

$2\frac{1}{2}^{2}$ About 1,000 feet back of $2\frac{2}{2}^{2}$, 100 feet south of house at horse ranch, about 300 feet below creek. Just inside of fence around barnyard.

$2\frac{1}{2}^{3}$ Left bank, about 2½ miles below $2\frac{2}{2}^{2}$, about 1½ miles below end of bottom, above Bijou Hills, about one-fourth mile below small creek. Twenty feet north of road up bottom just back of brush and timber line.

$2\frac{1}{2}^{4}$ On left bank, about 3 miles below $2\frac{2}{2}^{3}$, on lower side of small coulee where level bench land begins, about 125 feet from river and 150 feet south of old foundation of shack.

$2\frac{2}{2}^{5}$ On left bank, about 3 miles below $2\frac{2}{2}^{4}$, on level plateau about 130 feet from

* The description of the bench marks from Fort Benton to Cannonball and from Cannonball to Chamberlain will be found in the Annual Report, Chief of Engineers, for 1892, pp. 1800 *et seq.*, and for 1893, pp. 2306 *et seq.*

edge of abrupt slope to river, opposite foot of Durex Island, one-fourth mile above head of bottom. Upper house of Rhodes's ranch is about 1 mile below B. M.

$2\frac{3}{8}5$ One-fourth mile back of $2\frac{3}{8}5$ on gentle slope, 500 feet from foot of abrupt slope of high bluffs, 200 feet west of fence line.

$2\frac{3}{8}6$ Left bank, about 2 miles below $2\frac{3}{8}5$, about 1,000 feet west of house of J. Ham, 200 feet west of narrow lane, 10 feet south of wagon road, about 400 feet from river.

$2\frac{3}{8}7$ Left bank, about 1¼ miles below end of bottom, on small mound 200 feet west of creek and 600 feet west of house at Rhodes's horse ranch. Road to river 100 feet east of B. M.

$2\frac{3}{8}8$ Left bank, about 3 miles below $2\frac{3}{8}7$, 100 feet above small creek, 25 feet from edge of cut bank of river, one-half mile above head of bottom, opposite foot of Island No. 3. Philip Turgeon lives in coulee about 1,000 feet back of B. M.

$2\frac{3}{8}9$ Left bank, one-fourth mile above foot of bottom, opposite head of Island No. 1, in bottom 100 feet from river just back of single elm tree.

$2\frac{3}{8}9\frac{2}{3}$ About 500 feet back of $2\frac{3}{8}9$, on edge of bench land, one-half mile below red frame house of Turgeon.

$2\frac{3}{8}0$ Left bank, about 2¼ miles below $2\frac{3}{8}9\frac{2}{3}$, 75 feet above small creek, 125 feet from river bank, on small mound at head of bottom.

$2\frac{3}{8}1$ Left bank, about 3 miles below $2\frac{3}{8}0$, on small ridge 200 feet from river, one-fourth mile above where timber begins.

$3\frac{0}{3}1$ 1,000 feet back of B. M. $3\frac{0}{2}1$, in first bench above creek 300 feet west of log shack below creek, one-fourth mile below yellow frame house of Oldham.

$3\frac{0}{2}2$ Left bank, about 3 miles below $3\frac{0}{2}1$, on low bench about 350 feet below small creek, 200 feet from river, just above end of bottom. Log shack 100 feet below B. M. Road along bluffs back of B. M.

$3\frac{0}{3}3$ Left bank, on bottom opposite beginning of timber, about 2,000 feet below head of bottom, 200 feet from river. Warehouse on river bank one-half mile below B. M. Senator Jones lives on Cedar Creek 1 mile above B. M.

$3\frac{0}{3}3$ About 700 feet back of $3\frac{0}{3}3$, on edge of first bench.

$3\frac{0}{3}4$ About 3¼ miles below $3\frac{0}{2}3$, about one-half mile above where river strikes bluffs on narrow nose between two small coulees. Large chalk rock house at foot of bluffs just above B. M. Road from house straight out to river.

$3\frac{0}{3}5$ Left bank, about 3 miles below $3\frac{0}{3}4$, on broken foothills 100 feet from river, just above small coulee above head of bottom, about a mile above the Wheeler Ferry.

$3\frac{0}{3}6$ Left bank, on first bench, 400 feet from river, 25 feet south of road from Wheeler to river, 7 feet west of north and south wire fence.

$3\frac{0}{3}6$ In northeast corner of court-house yard at Wheeler, S. Dak.

$3\frac{0}{3}7$ Left bank, about 3 miles below Wheeler, on first bench, about 300 feet from river, about 100 feet above where heavy timber begins. Sod shack 1,000 feet northwest and log shack 600 feet above B. M.

$3\frac{0}{3}7$ About one-half mile back of $3\frac{0}{3}7$, on gentle slope from bluff, on south side of road and about one-half mile east of house of Matthew Biggins.

$3\frac{0}{3}8$ Left bank, about 3 miles below $3\frac{0}{3}7$, at the end of bottom, 1 mile below Pease Creek, 200 feet from river on foothills. Small graveyard 400 feet back of B. M. B. M. is regulation stone set 3½ feet in ground, with 3-inch ash pole 4 feet high set for surface mark. Pipe is gone.

$3\frac{0}{3}9$ Left bank, 3 miles below $3\frac{0}{3}8$, opposite head of Chicot Island, on low foothills 100 feet from river, just above head of bottom.

$3\frac{1}{2}0$ Left bank, about 300 feet from river, about 1 mile below upper end of Yankton Indian Reservation.

$3\frac{1}{3}0$ About three-fourths mile back of $3\frac{1}{2}0$, on first bench. Several Indian shacks on low bluffs one-half mile back of B. M.

$3\frac{1}{2}1$ Left bank, about 2 miles below $3\frac{1}{2}0$, on flat bottom 2¼ miles above White Swan, opposite head of small island. Large grove of trees 2,000 feet below B. M., and a church on bench land one-half mile back of B. M. B. M. is 350 feet from river and 25 feet south of road.

$3\frac{1}{2}2$ Left bank, at White Swan, 400 feet from river, 25 feet west of southwest corner of store, on small mound.

$3\frac{1}{3}2$ Right bank, at Fort Randall, 25 feet west of road to river, on first bench, at northwest corner of fort.

$3\frac{1}{2}3$ Left bank, about 2½ miles below White Swan, one-half mile below beginning of "Dugway," or head of bottom, on knoll in mouth of small creek; valley 300 feet back of road up bottom, 700 feet from river.

$3\frac{1}{2}4$ Left bank, about 3 miles below $3\frac{1}{2}3$, 300 feet from river, on level bottom about 500 feet above where the timber begins.

$3\frac{1}{3}4$ About 2,000 feet back of $3\frac{1}{2}4$, on long narrow ridge, like railway grade; road along top of ridge; two shacks and grove on ridge about 700 feet above B. M.

$3\frac{1}{2}5$ Left bank, about 3 miles below $3\frac{1}{2}4$, on first bench back of timber, about 300 feet above two Indian shacks; road to river from B. M.; large timber runs back toward bluffs 1,000 feet above and below B. M., three-fourths mile from river.

$2\frac{1}{2}^{6}$ Left bank, about 1¼ miles above Yankton Indian Agency, on bluffs, at lower end of bottom just above where road leads up the hill from bottom.

$2\frac{1}{2}^{7}$ Left bank, at Yankton Agency, in southeast corner of main office yard. Flagstaff stands 100 feet south of B. M.

$2\frac{1}{2}^{8}$ Left bank, about 2¾ miles below Yankton Agency, on low bench about 800 feet from river.

$2\frac{1}{2}^{8}$ About 800 feet back of $2\frac{1}{2}^{8}$; old slough bed 300 feet back of B. M.; wagon road 300 feet south of B. M., which crosses slough about 600 feet above B. M.

$2\frac{1}{2}^{9}$ Left bank, about 2¾ miles below $2\frac{1}{2}^{8}$, on low bench in bottom, 500 feet from river, 20 feet above road to river. Shack and grove about 1,800 feet back of B. M.; three large trees near B. M.

$2\frac{3}{2}^{0}$ Left bank, about 3 miles below $2\frac{1}{2}^{9}$, on bottom about 400 feet from river, about 1,000 feet above where heavy timber begins (probably in the river).

$2\frac{1}{2}^{0}$ Left bank, near edge of bank of old slough bed, which runs out to river bank 1,000 feet above B. M. Shack with grove one-half mile above, one-fourth mile above beginning of timber.

$2\frac{2}{2}^{1}$ Left bank, about 3 miles below $2\frac{1}{2}^{0}$, on ridge in bottom about 900 feet from river, just below where heavy timber leaves river and goes back toward bluffs.

$2\frac{1}{2}^{2}$ Left bank about 400 feet above Chouteau Creek, on long mound or ridge in old slough bed. Indian shack on mound 400 feet above B. M.

$2\frac{1}{2}^{2}$ On bench land, one-fourth mile back of $2\frac{1}{2}^{2}$, 1,000 feet from Chouteau Creek, where road crosses it. Two shacks about 700 feet back of B. M.

$2\frac{1}{2}^{3}$ Left bank, about 3 miles below $2\frac{2}{2}^{2}$, about 1,000 feet above where river strikes bluffs, on nose from bluffs above small creek.

$2\frac{1}{2}^{4}$ Left bank, 1 mile below head of bottom, about 700 feet from river. Grove 1,000 feet south, also grove 600 feet east of B. M.

$2\frac{3}{2}^{4}$ Straight back from $2\frac{3}{2}^{4}$, at foot of bluffs, 65 feet back of road along bluffs.

$2\frac{1}{2}^{5}$ Right bank, at Niobrara, Nebr., southeast corner high school yard. Is marked by △ pipe.

$2\frac{2}{2}^{8}$ Left bank, on low bluff above coulee, opposite ferry landing, 100 feet northwest from freight house, at Running Water, S. Dak.

$2\frac{2}{2}^{9}$ Left bank, 75 feet east from southeast corner of Henry Brooks's store, in Running Water.

$2\frac{3}{2}^{7}$ Left bank, on little bench in bottom about 2½ miles below Running Water, about one-half mile from river. Several houses in coulee straight back from B. M.

$2\frac{1}{2}^{8}$ Right bank, about 2½ miles above Springfield, S. Dak. About 1½ miles below head of bottom, in mouth of large coulee, 50 feet west from shack.

$2\frac{1}{2}^{9}$ Left bank, 75 feet from edge of cut bluff bank, about 500 feet south from Indian school, at Springfield, just east of fence.

$2\frac{3}{2}^{9}$ Southwest corner high school yard, at Springfield, S. Dak.

$2\frac{3}{2}^{0}$ Left bank, about 3½ miles below Springfield, on bench land, just at upper side of mouth of Silver Creek Valley. Road leads out of bottom into valley 15 feet east of B. M.

$2\frac{1}{2}^{1}$ Right bank, 2½ miles below Santee Agency, 400 feet from river, just where it strikes bluffs, 100 feet above creek. White house about 800 feet back of B. M.

$2\frac{3}{2}^{2}$ Left bank, 1½ miles below Bon Homme, back from ferry landing, 100 feet back of J. M. Cordle's house. Bridge across coulee 100 feet northwest of B. M.

$2\frac{3}{2}^{2}$ About 800 feet back of $2\frac{3}{2}^{2}$, on slope on lower side of creek, in pasture.

$2\frac{1}{2}^{2}$ Right bank, opposite foot of Bon Homme Island, just above large coulee, on bench land 200 feet from river.

$2\frac{3}{2}^{3}$ Left bank, three-fourths mile below Mennonite village. On slope to bottom just above third coulee below village, 100 feet south of road at foot of bluffs.

$2\frac{1}{2}^{4}$ Right bank, opposite Antelope Point, on sloping nose between two small coulees, 100 feet back from edge of low sliding bluffs. House 900 feet southwest of B. M.

$2\frac{3}{2}^{5}$ Left bank, about 4 miles below $2\frac{1}{2}^{4}$, on first bench 300 feet from river, 1,000 feet below creek, at beginning of bottom. Land belongs to Mr. Ulrich.

$2\frac{3}{2}^{5}$ About one-fourth mile back of $2\frac{3}{2}^{5}$, at foot of bluffs on slope, 50 feet above main wagon road, on Ulrich's land.

$2\frac{3}{2}^{6}$ Left bank, about 4½ miles above Yankton. Yankton Cement Works are about three-fourths mile straight back from B. M. Timber to river 300 feet above B. M.

$2\frac{3}{2}^{6}$ About one-half mile back of $2\frac{3}{2}^{6}$, 4 feet south of east and west fence, 500 feet west of east corner of fence. Cement works at foot of bluffs one-fourth mile back of B. M.

$2\frac{1}{2}^{7}$ Left bank, in southwest corner court-house yard, Fifth street and Douglass avenue, Yankton, S. Dak.

$2\frac{3}{2}^{8}$ Left bank, about 3 miles below Yankton, 8 feet south of main road from Yankton to the lower bridge across James River, at a point about one-half mile west of where road leaves old grade, in first clear strip of bottom below Yankton.

$2\frac{3}{2}^{8}$ About 1,000 feet back of $2\frac{3}{2}^{8}$, just south of fence around cornfield. Mr. Frazier's house is 800 feet back of B. M.

$2\frac{1}{2}^{2}$ Right bank, at Campbell's Point, on slope of grassy knoll.

$3\frac{1}{2}^{0}$ Left bank, 350 feet below mouth of James River, about 1,000 feet from river. House and grove of Mr. Walker is one-half mile north. William Esmay lives one-half mile east of B. M. B. M. is on land of Dougherty. Main road to Yankton is 600 feet north of B. M.

$3\frac{1}{4}^{0}$ One-fourth mile due north of $3\frac{1}{2}^{0}$, near fence corner.

$3\frac{1}{4}^{1}$ Right bank, about a mile above St. Helena, Nebr., near fence below creek on slope, into creek valley, down which a wagon road leads across bridge over creek.

$3\frac{1}{2}^{2}$ Left bank, opposite a point one-half mile below head of St. Helena Island, on flat bottom, about 1,000 feet from river. House and grove about 700 feet southeast.

$3\frac{3}{4}^{2}$ 1,000 feet back of $3\frac{1}{2}^{2}$, 15 feet north of road to St. Helena Ferry, about 400 feet east of small board shack, one-half mile west of frame house of Markeen Nelson, $2\frac{1}{4}$ miles due west of large brick house of Peter Smith.

$3\frac{1}{2}^{3}$ Left bank, about 1,500 feet from river, opposite foot of St. Helena Island, just east of county line Clay and Yankton counties, three-fourths mile south of brick house of Peter Smith and one-half mile southeast of white frame house of H. Smith.

$3\frac{1}{4}^{4}$ Right bank, 2 miles below St. James Landing, in timber bottom, 150 feet northeast from log house of Theodore Witthouse, near road to river, about 1,000 feet from river.

$3\frac{1}{2}^{5}$ Left bank, about $7\frac{1}{2}$ miles above Vermilion, about one-fourth mile from river, above beginning of timber, about 400 feet back of sawmill, 20 feet east of road to river, 1 mile above high sand hills on river bank.

$3\frac{1}{4}^{6}$ One-fourth mile back of $3\frac{1}{2}^{5}$, in pasture east of road, opposite house of Chris Larson, 1,000 feet south of main road to Vermilion.

$3\frac{1}{4}^{6}$ Right bank, in bottom 3 miles below $3\frac{1}{4}^{4}$, 3,200 feet below end of timber, 2,300 feet from river, near fence around farm yard of F. W. Reifenmath.

$3\frac{1}{2}^{6}$ Left bank, 3 miles above Vermilion, 300 feet east of house of Ole Temple, 1,300 feet north of main road from Vermilion.

$3\frac{1}{4}^{7}$ Right bank, in Line Creek Valley, 30 feet northwest from schoolhouse, about $1\frac{1}{2}$ miles below ferry at Mulberry Point, about 1,600 feet from river.

$3\frac{1}{2}^{7}$ Left bank, in northwest corner court-house yard at Vermilion, S. Dak.

$3\frac{1}{2}^{8}$ Left bank, about one-half mile from river, just below mouth of old cut-off slough, a white house 1,800 feet south and another 800 feet southwest, in pasture land.

$3\frac{1}{4}^{8}$ Left bank, 3 miles below $3\frac{1}{2}^{8}$, 1,600 feet from river, just back of timber. House 800 feet southwest; wagon road from B. M. straight north to railway; schoolhouse 1 mile north of B. M.

$3\frac{5}{2}^{0}$ Left bank 25 feet west of schoolhouse at Burbank, about 1,000 feet north of railway.

$3\frac{5}{4}^{0}$ About one-third mile back of $3\frac{5}{2}^{0}$, just west of main road north from Burbank, at southwest corner of first grove along road.

$3\frac{5}{2}^{1}$ Left bank, three-fourths mile north from house of James McGonnagle, and about one-half mile northeast of J. W. Hammond's white house and grove. Donnelly school, district No. 12, is about 1 mile southeast, in N. E. $\frac{1}{4}$ sec. 7. T. 91, R. 50, on flat bottom; no fence near B. M.

$3\frac{5}{2}^{2}$ Left bank, about 3 miles below $3\frac{5}{2}^{1}$, about one-fourth mile from river, in edge of cornfield south side of road, 180 feet southeast of house of Gude Djorlais (pronounced De Jella).

$3\frac{5}{4}^{2}$ About one-fourth mile back of $3\frac{5}{2}^{2}$. Frame house 150 feet northwest of B. M.

$3\frac{5}{2}^{3}$ Left bank, about $1\frac{1}{2}$ miles west from Elk Point, 200 feet north from house of D. W. Carter, about 2 miles from river.

$3\frac{5}{2}^{3}$ Southeast corner of court-house yard at Elk Point, S. Dak.

$3\frac{5}{2}^{4}$ Left bank, about $4\frac{1}{2}$ miles south of Elk Point, on road to Ponca Ferry, in southwest corner of Pleasant Grove district No. 20, school yard. A. S. Bland lives opposite B. M.

$3\frac{5}{4}^{5}$ Right bank, at foot of bluffs, about $\frac{1}{2}$ mile below Ponca Landing. Is in farm yard of John Austin, about 300 feet southwest from his dwelling house, and 250 feet south of road between Ponca and Ponca Landing.

$3\frac{5}{2}^{5}$ Left bank, one-half mile north from Ponca Ferry, 1,000 feet east of main road to Elk Point, and on the Stough farm, 200 feet south of the farm buildings, Clarence Cheeny, tenant.

$3\frac{5}{4}^{6}$ Right bank, $3\frac{1}{2}$ miles below Ponca Landing, in creek valley, 1,200 feet from river where it strikes the bluffs. George Barben lives near B. M.

$3\frac{5}{2}^{6}$ Left bank, opposite $3\frac{5}{4}^{6}$, 1 mile from river, on west side of road to river. W. R. McKinsey lives on opposite side of road.

$3\frac{5}{2}^{6}$ Three miles due north of $3\frac{5}{2}^{6}$, about 3 miles west from Jefferson, 50 feet northwest from schoolhouse at crossroads.

$3\frac{5}{2}^{7}$ Left bank, 6 miles by river, 2 miles across from $3\frac{5}{2}^{6}$, near fence corner, 30 feet west of road along river bank. House 800 feet above B. M.

$3\frac{5}{2}^{8}$ Left bank, about $2\frac{1}{2}$ miles below $3\frac{5}{2}^{7}$, on north side of road, 200 feet west of bridge across slough, 400 feet from river. Yellow house and grove three-quarters mile above B. M.

$3\frac{5}{2}^{8}$ Northwest corner school yard at Jefferson. Blacksmith's shop across street.

[1] Left bank, about 4 miles south of Jefferson, on north side of road, opposite e of A. P. Keendy. John Gibson owns land. Section line is 75 feet south of B. bout one-quarter mile from river, at end of big willow bar in bend.
[2] Right bank, opposite upper end of cut-off forming McCook Lake, where river s east, about 1 mile from river, in southeast corner school yard, on west side of straight out from river. David Clark lives 1,200 feet south of B. M.
[3] Left bank, about 400 feet south from depot at McCook, 130 feet back of school- se.
[4] (Mo. R. Com.) In southwest corner of court-house yard, Sioux City, Iowa.

ORT OF WILLIAM G. PRICE ON DISCHARGE OBSERVATIONS OF MISSOURI RIVER FROM GREAT FALLS, MONT., TO SIOUX CITY, IOWA.

SIOUX CITY, IOWA, *October 20, 1893.*

IR: I have the honor to submit the following report of discharge measurements he Missouri River from Great Falls, Mont., to Sioux City, Iowa. The party isted of myself and Mr. C. A. Swift. One boatman, with a skiff, was employed ach point where measurements were made. We traveled from point to point by road.

he outfit consisted of a Price current meter No. 49, with electric register, bat- of four dry cells, stop watch, steel tape measure, pocket sextant, insulated cop- wire and reel, lead with line, four survey poles, and an engineer's level. The er was a new one, and was first rated in the Sioux River, at Riverside, on August 893.

he method of measuring the discharge at each point was as follows: A section selected and marked with one flag pole on one side of the river and two flag s on the other side, one pole being close to the water and the other being far k, so as to give a well-defined range. A base line was then laid off at right les to the section and running from it upstream or downstream, and marked at end with another flag pole. The length of the base line was made equal to the nated width of the river in even hundreds of feet. The distance from the base to the water's edge was then measured. The meter was run and soundings taken a skiff, which was anchored with two anchors, each of which usually con- d of a cast-iron wagon thimble and skein. These made very good anchors, and usually the only articles that could be secured for this purpose. The anchor s were one-fourth inch cotton braided rope. The anchors were placed far apart, the ropes led to the bow of the skiff, forming a V, which held the skiff quite ly. At times, when the wind blew from the land or upstream, a third anchor thrown out from the stern of the skiff. The skiff was located at each point on ection by an angle taken with a sextant to the flag poles at the ends of the line, the observer being in the skiff with his head on the section and at the elevation above the water surface as the flag poles. Soundings were measured a graduated pole up to ten feet and deeper places with the lead and line, the h on the line being measured with the pole as soon as each sounding was taken. e meter was lowered to mid-depth for each measurement of velocity, and was ended, with its weight, by a cotton braided rope one-fourth of an inch in diam which was tagged to feet. The rope led from a reel in the skiff over a sheave e end of a wooden frame, which projected 3 feet upstream from the bow of skiff. The reel was attached to this frame, and the insulated wires were carried he same reel, being wound around the rope. The points where the skiff was ored were made near together where the greatest differences in depth and veloc- were noted and farther apart at other places. These points were usually near ther at each bank and farther apart out in the stream. The time of one hundred olutions of the meter wheel was taken for each measurement of velocity, except ery swift and very slow currents, when the time of a greater or less number of olutions was taken. In reading the register I used only one of the circles, which raduated to record one hundred revolutions, and I think that if the registers e made with only one graduated circle the machinery could be simplified so they ld not easily get out of order. The mid-depth velocities were reduced to the n velocity by multiplying each by $\frac{98}{100}$. All computations have been made by Mr. . Swift and myself independently and checked.

n September 22 and 27 the meter was again very carefully rated at Sioux City. meter was suspended from a skiff in the same way it was used in discharge work. skiff was hauled back and forth along a wire which was stretched along the nel of Sioux River where the current was very slow. The skiff was turned around ach end of the wire, and the trip up and down was made at as near a uniform speed ossible. The wire was made of eight lengths, 70 feet each, of wire rope clothes soldered together. Two of the soldered points 280 feet apart were marked with string, and the distance between them was measured while the wire was stretched

and the correction for the sag of the wire was made. This wire rope was stretched between two hand-driven piles, whose tops were made rigid by ropes leading down to the bottom of other hand-driven piles. A one-fourth-inch cotton rope was stretched between the same piles and parallel with the wire rope, and it was passed once around a reel in the skiff, so that by turning the crank of the reel the skiff could be propelled at any desired speed.

Twenty-seven round trips were made up and down over the base. The data was reduced to revolutions per second and velocity in feet per second, and the up and down trips combined to eliminate the effect of the river current. The resulting twenty-seven points were plotted on coordinate paper, and an elastic curve drawn through them by bending a true steel straightedge between three heavy paper weights.

The reduction table was made direct from the plotted curve.

Very respectfully, your obedient servant,

W. G. PRICE,
Assistant Engineer.

Capt. H. F. HODGES,
Corps of Engineers, U. S. A.

REPORT OF H. C. GOULD, ASSISTANT ENGINKER.

ROCKHAVEN, N. DAK., *July 1, 1894.*

I have the honor to submit the following report on water gauges, repairs to boats, ice harbor at Rockhaven, etc., during the year ending June 30, 1894:

WATER GAUGES.

Townsend, Mont.—Weekly reports have been received regularly all the year from this station through the courtesy of the Missouri River Commission.

Fort Benton, Mont.—This gauge was operated all the year.

Wolf Point, Mont.—Readings were continued until the river closed November 23, 1893, and were resumed when the river opened April 5, 1894.

Fort Buford, N. Dak.—Readings were stopped when the river closed November 26, 1893, and were resumed March 18, 1894, when the ice went out.

Bismarck, N. Dak.—This gauge was operated all the year.

Pierre, S. Dak.—On April 20, 1894, I inspected the gauge here which is operated by the Weather Bureau. It is a staff gauge in place only during open river. The staff had not yet been set up this year, and the observer was keeping the record by measuring vertically to the water surface from a fixed point whose height above the zero was known. He expected to have the gauge in place in a few days.

Running Water, S. Dak.—The record of this gauge has been continuous except from November 26, 1893, to March 4, 1894, when the river was closed by ice.

On April 11, 1894, the gauge was removed by the observer, as high water was cutting the bank in front. The record was kept by temporary stakes till April 17, when I set up the gauge again.

Sioux City, Iowa.—The record of this gauge, operated by the Missouri River Commission, was continuous during the year.

Miscellaneous.—The usual copies of the records and the hydrographs were kept up during the year.

The elevation of gauge zeros at Fort Benton, Wolf Point, Fort Buford, Bismarck, and Running Water were checked during August and September, 1893, by Assistant Engineer W. G. Price while making discharge measurements.

The drawing and specifications of the new movable trussed beam cable gauge mentioned in last year's report were completed February 17, 1894. Bids were obtained by circular notices, and the making of a trial gauge was awarded to the Missouri Valley Bridge and Iron Works, of Leavenworth, Kans., for $150, delivered at Sioux City. I inspected the gauge at Leavenworth on March 26, 1894. It was received in Sioux City April 2; was set up near the railroad bridge and readings commenced April 5, 1894, for the purpose of comparing its operation with the gauge on bridge. The apparatus proved quite satisfactory, but some changes in detail were found desirable, the form of which have not yet been decided upon.

REPAIRS TO UNITED STATES SNAG BOAT MANDAN.

This work was in progress at the beginning of the year. The lengthening of the hull and building of the wheel and cylinder beams, under agreement with F. Spencer, were completed in July, 1893, the total cost of Spencer's work being $4,924.22.

The Haley Foundry and Machine Company then commenced setting up the engines. The boiler was inspected at Red Bank, N. J., and was received in Sioux City August

.893. The boiler capstans, capstan engines, pumps, siphons, smokestack, etc., ɔ set up and connected by the boat's crew. The house was built by hired labor, ·ly all materials being purchased on written or verbal bids.

verything was completed so that the trial trip was made on September 7, 1893, ı Howard street landing to the Big Sioux River and return. The engines worked ıfactorily and were accepted. The boiler was not entirely satisfactory. Consid- ıle water was carried over into the engines and the steam pressure was unsteady, it was thought these defects might decrease when the boiler became cleaner in and the firemen more experienced.

ter a few days' work sluicing in the mouth of the Big Sioux River the *Mandan* ted on a snagging trip up the river. When about 25 miles above Sioux City the nes were disabled by the breaking of the pistons and the crossheads. It is sup- d the accident was caused by water in the cylinders. The boat was brought t to Sioux City and the engines were repaired. It was also decided to place an tional steam drum on the boiler. This drum was built in the form of an annular , 4 feet high, outside diameter 4 feet 4 inches, inner shell 28 inches diameter. outer shell is one-half inch thick, the heads and the inner shell are five-eighths thick. A coating of asbestos plaster, 1½ inches thick, was laid on heavy wire ing around the sides and on top. There was great delay in getting material for drum, so it was not set up and connected until after the boat had been placed in ter quarters in the Big Sioux River. Ice having formed in the river a trial trip d not be made.

uring the winter all of the steam supply pipes were covered with an asbestos ıaration, and the steam drum was inclosed in a wooden casing.

ıe boat left her winter quarters April 10, 1894, and went to the Howard street ling. After taking on supplies she went up the river April 25, 1894, to commence gging. The boiler and machinery were found to work very satisfactorily, except ; some gear wheels in the capstan machinery proved too light, broke down, and e replaced by stronger wheels.

FLEET FROM JUDITH, MONT.

he repairing and launching of these boats, in progress at the beginning of the r, was completed, and the fleet started down the river July 21, 1893. A stop of ɔe days was made at Fort Buford, N. Dak., to take on two hoisting engines and er Government property stored there. They arrived at Rockhaven, 6 miles above narck, on August 15, 1893, and the party was disbanded.

etween September 28 and October 10, 1893, all the boats were hauled out on the k, except the small steamboat *Josie* and one of the 65-foot barges. The cap- ıs, large blocks, jack screws, and other property for hauling out were loaded on barge, and with the *Josie* left Rockhaven October 11, in charge of Mr. L. Whisler, Sioux City. They arrived at Sioux City November 7, 1893, and were placed in Big Sioux River, where the property was used in hauling out the snag boat *es B. McPherson.*

ı May, 1894, the battens and remains of tarred-paper covering on roof of store ɨ were removed, a new covering of cedar shingles was put on, and painted a ·y coat of mineral paint.

ıring May and June, 1894, the old canvas covering on roof of quarter boat was aced by a new covering of similar material, painted two coats, and sanded.

ICE HARBOR AT ROCKHAVEN, N. DAK.

ɔtailed drawings and specifications for mooring posts were prepared during Jan- and February, 1894. Bids for furnishing ironwork for ten posts were invited ircular notices and opened February 26, 1894. The bid of the Gillette-Herzog ufacturing Company, Minneapolis, Minn., for $974, delivered at Minneapolis, accepted. The posts are of lap-welded steel pipe, 10 feet long, 15 inches out- diameter, five-eighths inch thick, with cast-iron cap fastened by 4 tap screws. ½ feet below the top is a strap of iron 1 inch by 6 inches, from which 2 iron rods, ·hes diameter and 20 feet long, lead upstream in the direction approximately ɔsite to the strongest pull, and down through a block of concrete 6 feet by 3 by 16 inches, and a cast-iron plate on back of block. At right angles to these another iron rod, 1½ inches diameter by 16 feet long, leads backward from the r and downward to a similar fastening, 4 feet by 3 feet by 16 inches. The bot- of the post stands in a block of concrete 3 feet square by 1 foot thick. The s were to set on top of the river bank, the embankment to be filled in around n, leaving the post projecting 2 feet above the surface, and then to be filled ı concrete.

accordance with your instructions I left Sioux City, April 28, 1894, for Rock- ɔn to commence construction of the harbor.

An office and quarters for myself and assistant were fitted up in one end of the old quarter boat, which was hauled out on the bank last October.

The boundary lines of the land already purchased, and that still to be acquired, were laid out and connected with all the adjacent land survey corners and with the triangulation system of the Missouri River Commission. Cross sections of the bank along the whole length of the harbor were taken and grade stakes were set down to station 29.

Temporary bins for storing sand and broken rock were built near the middle of the place to be occupied by the mooring posts; a platform, 16 feet square, of 2-inch plank, on which to break rock, was built at one side of the bins, and on the other side a similar platform was placed for mixing concrete. Good rock for concrete was found along the bank near lower end of harbor, hauled in wagons to the platform and broken by hand, about 17 yards being prepared. Bids for furnishing 12 yards sand were invited by public notice and opened May 10. After examinations of the localities the lowest bid, $1.85 per cubic yard, delivered here, was accepted. Delivery was completed May 22.

The mixing of concrete and molding of the anchor blocks were commenced May 23, and occupied parts of several days until June 4.

The concrete was mixed by hand on the platform and hauled in a wagon to the post locations.

The blocks were molded in flasks made of 2-inch plank, with one side bolted on so that after the block was set this side was taken off and the block turned out nearly in its final position. The foot block was molded in place.

The ironwork for the mooring posts was brought up from Bismarck by the snag boat *Josephine* and delivered May 31.

The erection of the mooring posts was completed June 4.

Clearing of brush and trees from the low flat along front of upper part was commenced May 9 and finished May 13.

The old crib, built of logs drift-bolted together and filled with rock, was taken out as far as the water permitted.

Grading was started May 16 on the low flat with 8 teams and scrapers. The forces of teams and men were increased as the work developed until on June 15, 26 teams and teamsters with wagons and scrapers and 65 men were employed.

Some ledges of rock were met, in nearly horizontal layers from 1 foot to 3 feet thick. Much of it was soft and shaly, but the lower layers were nearly all an excellent hard sandstone. There were seams and cracks running through it, making its removal easy and rapid by means of wedges and bars. All the rock was deposited in or near the location for the head dike.

To June 27, inclusive, the total excavation measured in place amounted to 13,717 yards, including 858 yards of rock measured in the dump. The grading is finished down to an average elevation of 10 feet above low water, from the head of the lower end of the tract now purchased, the distance being nearly 1,300 feet. On account of the unexpected delay in procuring title to the additional land, and the continued high water the grading was entirely suspended on June 30, but will be resumed again when the water falls sufficiently or the title to the needed land is acquired.

Very respectfully, your obedient servant,

H. C. GOULD,
Assistant Engineer.

Capt. H. F. HODGES,
Corps of Engineers, U. S. A.

A A 2.

REMOVAL OF SNAGS AND OTHER OBSTRUCTIONS IN MISSOURI RIVER ABOVE SIOUX CITY, IOWA.

PROJECT.

The approved project contemplates the use of the available funds in the work stated on that part of the Missouri River above Sioux City where boats may be running and where it is most needed. The work is done by hired labor.

But one appropriation has been made for this work, viz, by the sundry civil bill of March 3, 1893, $50,000.

CONDITION AT BEGINNING OF YEAR.

ifore the appropriation made in the sundry civil bill of 1893 the : of removing snags had been carried on under allotments from the ral appropriations for the improvement of the river. When the ial appropriation became available, on July 1, 1893, there were e boats on hand which had been purchased or built from the gen- appropriations. The condition of the fleet at the beginning of the l year was as follows:

iag boat *James B. McPherson*.—A steel-hulled stern-wheel snag boat, hed in 1891 by the Iowa Iron Works, of Dubuque. This boat is 170 long by 36 feet beam, with a nominal capacity of 340 tons. Since the ation of her stern in the winter of 1893–'94 she draws 31 inches an average load. She has a compound condensing engine. At beginning of the year she was lying up in the Big Sioux River ing a favorable working stage.

iag boat *Josephine*.—A wooden-hulled stern-wheel snag boat, pur- ied in 1885 at Bismarck, N. Dak. This boat is 183 feet long by eet beam, with a nominal capacity of 331 tons. She draws 29 es with an average load, and has single-expansion noncondensing nes. At the beginning of the year she had just been remodeled was lying up during the high water.

iag boat *Mandan*.—A steel-hulled stern-wheel snag boat, built in as a snag scow, without motive power, by the Carondelet Boiler Sheet Iron Works, of St. Louis. This boat is now 138 feet long by et beam, with a nominal capacity of 150 tons. She draws 26 inches an average load, and has compound noncondensing engines. At beginning of the year she had just been lengthened to her present , and was having her engines and boiler put in.

OPERATIONS DURING THE YEAR.

ie *McPherson* began active work on July 26, 1893, by sluicing an ance channel into the Big Sioux River. She began snagging work uly 31 and continued until November 4. On that date she entered winter harbor at the mouth of the Big Sioux River.

uring the season's work great trouble was experienced on account ie fact that the rudders of the boat were readily knocked off when- the stern grounded. Much time was lost after each accident in ing for the necessary forgings and for the subsequent repair. On account it was thought advisable to remodel the boat, providing tern with skegs, to give support to the bottom as well as to the of the rudder stocks. Immediately upon arrival in the winter or she was hauled out on ways, and bids were asked for doing the t in accordance with plans already prepared. On November 30, , the tenders were opened and the work awarded to the Iowa Iron ks, of Dubuque. It was finished on May 29, 1894, forty-nine days the time specified in the contract. The boat was launched on 31 and began work on June 11, continuing until the close of the l year on the reach between Sioux City and Chamberlain.

iere has been no trouble with her rudders this season. As an inci- al result of the alterations the trim of the boat has been improved uch that she now draws 6 inches less than formerly with her full

ie *Josephine* started on June 25, 1893, for the reach of river allotted er. She began snagging work on August 3, but was almost imme-

diately disabled by breaking one leg of her shears. Another pair was shipped up, and work began again on August 15 and continued until November 15, when she went into winter quarters in the Big Sioux River. On April 13, 1894, she began operations again, continuing until the close of the fiscal year on the reach between Fort Yates and Berthold Agency.

The *Mandan* was undergoing alterations at the beginning of the fiscal year. On September 7, 1893, the engines and boiler were reported in readiness and a successful trial trip made. On September 12 the boat started upstream, doing two days' work sluicing the bar at the mouth of the Big Sioux. On the 16th and 17th the pistons of the two low-pressure cylinders broke, and the boat was towed to Sioux City for repair. These repairs, with the construction of an additional steam drum to provide more reservoir capacity for the boiler, took the rest of the autumn, until it was time to go into winter quarters at the Big Sioux Harbor. On April 25, 1894, she started work, and continued until the close of the fiscal year on the reach between Chamberlain and Fort Yates. The engines were ordered early in the spring of 1893 and, with the boiler, were put on the boat during the following summer. They are two in number, each having one low-pressure cylinder, with interior dimensions of 16 by 48 inches, surrounding a high-pressure cylinder with interior dimensions of 7 by 48 inches. The low-pressure piston is therefore an annular ring sliding on the outside of the high-pressure cylinder, which is 8½ inches in diameter. The boiler is of the Roberts water-tube pattern, which has been but little used on the Missouri River. Since the reservoir capacity was increased by an additional steam drum it has worked well, and seems economical of fuel. A more extended trial is necessary before the effects of the muddy water on the tubes can be stated. With a condenser to give clear water, it would undoubtedly prove as successful here as elsewhere.

Summary of the work of the boats from July 1, 1893, to June 30, 1894.

Snag boat.	Snags removed or destroyed.	Snags abandoned.	Miscellaneous obstructions removed.	Trees cut.	Working days.	Miles run.	
						Up.	Down.
McPherson	327	4	43	1	104	638	597
Josephine	484	17	14	1,841	143	1,978	1,345
Mandan	224	.....	3	.....	62	593	114

WORK REQUIRED.

The work of the snag boats is necessarily continuing in its nature. Unless permanent works of rectification be completed, which shall confine the river to one channel and prevent it from eroding its banks, it will yearly continue to make new snags or by its shifting to expose old ones formerly far from the channel.

An expenditure of $50,000 annually is needed to operate the boats and keep them in repair. Their work is of more value to the small commerce of the river than any other possible at the same cost. To place it beyond danger of suspension the appropriation for it should be continuous. The recommendation of last year that this be done is renewed.

Money statement.

July 1, 1893, balance unexpended		$50,000.00
June 30, 1894, amount expended during fiscal year		45,483.59
July 1, 1894, balance unexpended		4,516.41
July 1, 1894, outstanding liabilities	$3,390.19	
July 1, 1894, amount covered by uncompleted contracts	1,126.22	
		4,516.41
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		50,000.00

A A 3.

EXAMINATION OF MISSOURI RIVER BETWEEN THREE FORKS AND CANYON FERRY, MONTANA, TO DETERMINE AVAILABILITY OF WATER POWER.

[Printed in House Ex. Doc. No. 96, Fifty-third Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, January 22, 1894.

GENERAL: I have the honor to make the following report of the examination of Missouri River from Three Forks to Canyon Ferry, Mont., with a view of determining at what points, if any, use might be made of water power for manufacturing or other purposes without unreasonably impairing the navigability of that portion of said river.

This examination was ordered by the river and harbor act approved July 13, 1892. A sum of $2,500 was especially appropriated for the work, which was not classed as a preliminary examination.

The Missouri River is formed by the confluence of the Jefferson, the Madison, and later the Gallatin rivers, which come together near the towns of Three Forks and Gallatin City. The Northern Pacific Railway strikes the river at the mouth of the Gallatin, 5 miles below the town of Three Forks, and follows the right bank for 41 miles to Townsend, where it crosses and leaves the valley. For about 80 miles below Townsend there is no railroad along the river. From Three Forks to Canyon Ferry the distance along the channel is 81 miles.

The river is from 250 to 600 feet wide, with clear water, gravelly or rocky bed, and fairly stable banks in the bottom land. For a considerable part of the whole distance the flow is through rocky canyons, with but little bench between the bluff and the water's edge. The fall is very great, averaging 4.8 feet to the mile, and is located principally at ripples which separate pools where the surface is nearly level. In the pools the depth is considerable, reaching 25 feet at low water in places. On the ripples the depth is very small; a boat drawing 18 inches could not find a natural channel of sufficient depth to permit passage at low water. There is no navigation on this part of the river.

The discharge is about 3,300 cubic feet per second at low water, and the rise from low to high water level about 8 feet.

The portion of the river included within the limits named had been surveyed in 1890 under direction of the Missouri River Commission. The project for the present examination contemplated the selection, by study of the commission's maps and by preliminary reconnoissance, of those points which should seem most suitable for the purpose named,

and to make detailed surveys of the sites thus selected, determining, as far as practicable, the character of the foundation.

The work was under charge of Capt. C. F. Powell, Corps of Engineers, until April 27, 1893; on that date it was transferred to me, in accordance with General Orders No. 86, series of 1893, from the headquarters of the Army.

In October, 1892, a preliminary reconnoissance was made by the officer in charge, and certain points selected for detailed examination. Before making the reconnoissance notices were displayed in the post-offices contiguous to the stretch of river, and letters were sent to persons who might be interested in the matter, asking information as to desirable or available sites for dams. No answers were received recommending any place within the limits set by the act.

In July, 1893, the maps of the survey of 1890 were examined and traced and the places selected for the detailed surveys. The sites chosen were those which seemed to offer facilities for the construction of a short, high dam with good natural abutments, to give opportunity for the construction of a lateral canal with lock for passage of boats, and to be located where the backwater would inflict the least possible injury.

On August 30 a party under charge of Mr. E. D. Vincent, assistant engineer, was sent to Three Forks and proceeded down the river in a skiff, stopping at the points selected, and making detailed surveys connected with the secondary triangulation stations and the bench marks of the survey of 1890. Maps of these surveys are herewith, marked sheets 1, 2, 3, 4, and 5.

Seven places were found which fulfill to a reasonable extent the necessary requirements. These are located on the accompanying inch-mile Charts LXXXIII, LXXXII, LXXXI, of the survey of the Missouri River Commission.

Site No. 1: For location see Map LXXXIII; for local survey see sheet 1 of inclosures.

This location is at Eagle Rock, 6 miles below the mouth of the Gallatin River.

It is in section 23, township 3 north, range 2 east of the Montana principal meridian, belonging to the Northern Pacific Land Company by the terms of the charter of the railroad. The river here is 550 feet wide.

The rock crops out on the right bank in a steep limestone bluff, giving a good natural abutment. The ledge dips downward, crossing the stream, and is overlaid with gravel and clay. On the left bank the ground is gravelly and rises more gradually.

At the site the level of the railroad track is 19.6 feet above low water, and the grade rises upstream. The pool above the dam could be raised 16 feet above the stage of the survey, or 17.4 feet above low water without danger to the track.

The flood line of such a pool would extend 3 miles upstream and would embrace 34 acres outside the banks. Of this land 12 acres belong to the Northern Pacific Land Company and the remainder is still unentered. There are no settlers on any of the land affected.

The dam to give the proposed difference in level would be 1,450 feet long. To get a rock foundation for the whole length would be expensive and difficult. About 6,500 horse power would be developed at low water.

The weir for passage of the flood water should extend from the right abutment. The lateral canal and lock for passage of vessels should be near the left abutment.

Additional dam site No. 1: An alternative location is shown on the ne map, viz, sheet 1 of the local surveys. It is located 2,600 feet ther upstream, but is on the same property. A dam here would shorter than at the lower site, but a similar difficulty in the founda- n would probably be found. The pool level allowable without dan- r to the track is 14.4 feet above the stage of the survey, or 15.6 feet ove the low water. This lift would develop 5,800 horse power at w water, with a dam 675 feet long.

In this case the wasteweir should be next the left abutment and the teral canal next the right. The area flooded outside the banks is 25 res, located principally on lands still open for entry.

Dam site No. 2: For location, see inch-mile Map LXXXIII. For local rvey, see sheet 2 of inclosures.

This site is 19 miles below the mouth of the Gallatin River, and is arly 51 miles from Helena, on the Northern Pacific Railroad, the act position of the cross section taken being 715 feet downstream m the fifty-first milepost on the railroad.

It is on land as yet unsurveyed. After subdivision it will be in sec- n 11, township 4 north, range 2 east of the Montana principal merid- n, and will belong to the Northern Pacific Land Company by the rms of the railroad charter.

On the left bank the bluff comes close to the water's edge; on the ght bank it is separated from the river by a bench of about 200 feet. nder the bed of the stream rock is found overlaid by 4 to 9 feet of nd and gravel. The river is 370 feet wide.

To carry the dam from the rock abutment on the left to high ground the right bank will require a length of 750 feet. The wasteweir ould be next the left abutment, and the lateral canal and lock should cut through the bench between the railroad track and the present ter's edge.

A lift of 17.8 feet above the stage of the survey, or of 19.2 above w water, would bring the level of the lower pool within 3 feet of the se of the rail of the road, but would flood the track to a depth of 3 feet at a depression about half a mile above. To make this site ailable the lift must be reduced to 14.4 feet above low water or the ack must be raised at the depression. This latter work would cost t little and is preferable to reducing the lift nearly 5 feet. The dif- rence in level of 19.2 feet would develop about 7,200 horse power at w water. With the above lift the flood line would extend 3½ miles stream. Thirty-two acres of land would be flooded. All this is ll unentered, with the exception of the right of way, 400 feet wide, the Northern Pacific Railroad.

Dam site No. 3: For location, see inch-mile Map LXXXIII; for local rvey, see sheet No. 3 of inclosures.

This is located 20.75 miles below the mouth of the Gallatin River d 49.4 miles from Helena, on the Northern Pacific Railroad, the act location of the section sounded being 3,225 feet downstream of e railroad post marking 50 miles from Helena. It is on unsurveyed nd, which, if sectionized, would fall principally in section 1, township north, range 2 east of the Montana principal meridian, and would long to the Northern Pacific Land Company by the grant to the rail- ad from the United States.

On the left bank the rock in place extends to the water's edge and ns under the river bed, overlaid with from 2 to 10 feet of broken ck and gravel. On the right bank the rise is gradual, being about feet above low water at a point 200 feet back from the river, and

the underlying rock being at a depth greater than 25 feet from the surface of the bench.

To place the level of the upper pool 18.8 feet above low water will develop about 7,000 horse power at low water, and will not endanger the railroad, the flood line being 3 feet below the lowest point of the base of the rail. The river here is 275 feet wide. The dam should be 440 feet long. The weir for the waste water should extend from the left or rocky abutment. A lateral canal and lock pit might be excavated through the bench on the right bank. The area flooded by the backwater comprises 28 acres, which is all still unentered, with the exceptions of the right of way of the railroad and a private placer claim.

Dam site No. 4: For location, see inch-mile Map LXXXIII; for local survey, see sheet 3 of inclosures.

This site is located 21 miles below the mouth of the Gallatin River, and is 48.9 miles by rail from Helena. The exact location of the section sounded is 535 feet downstream from the railroad post marking 49 miles from Helena. It is in the upper end of the canyon next above Toston, and occupies land as yet unsurveyed. After sectionizing it will fall in section 7, township 4 north, range 3 east of the Montana principal meridian, and will belong to the Northern Pacific Land Company. The river here is 325 feet wide.

Rock in place is available for both abutments and for the foundation at a probable depth of about 10 feet below the low-water plane. The dam would be 650 feet long. The weir should be next the right bank. The canal and lock pit should be excavated in the stratum overlying the rock on the right bank.

A pool level 16.2 feet above the stage of the survey, or 17.8 feet above low water, would not approach the base of the rail of the Northern Pacific Railroad within less than 3 feet. This lift would develop 6,675 horse power at low water. The backwater would extend 2½ miles upstream, and would flood 14 acres of unoccupied land, as well as a private placer claim.

The lift could be increased to 26 feet without materially increasing the flooded area were it not for the low level of the Northern Pacific Railroad track.

Dam site No. 5: For location, see inch-mile Map LXXXIII; for local survey, see sheet 4 of inclosures.

This site is located 22.5 miles below the mouth of the Gallatin River and opposite the Northern Pacific Railroad post marking 47 miles from Helena. It is on unsurveyed land. After sectionizing it will fall in section 6, township 4 north, range 3 east of the Montana principal meridian.

The actual site of the dam is occupied on the right bank by railroad's right of way and on the left bank by a private placer claim. The river here is 280 feet wide, and the rock in place is available for the foundation and the left abutment. To get a rock abutment on the right bank the dam would have to cross the railroad.

If the level of the upper pool were placed 19 feet above the stage of the survey, or 20.6 feet above low water, the railroad would not be endangered, as the base of the rail at its lowest point would be 3 feet above the water. The land overflowed would be small in area, but the damage inflicted upon mining claims would be considerable, and part of an irrigation ditch would be flooded.

The dam here would be 550 feet long, and the lift of 20.6 feet would develop 7,725 horse power. Great increase of power with small increase

damage by backwater might be obtained here if the track of the ilroad were at a high level. The weir should be next the left abut-ent and the lateral canal and lock should be placed in the bench on e right.

Dam site No. 6: For location, see inch-mile Map LXXXI; for local sur-y, see sheet 5 of inclosures.

This is located at Canyon Ferry, 75.5 miles below the mouth of the allatin River. It is 33 miles below the point at which the railroad aves the valley, and is 18 miles by wagon road from Helena. The nd on which it falls is in section 10, township 10 north, range 1 west the Montana principal meridian, and is held in the name of Court heriff.

The river here is 260 feet wide and rock in place is available for oth abutments, with but little extra length. To reach the bed rock r the foundation would probably require considerable excavation.

Any useful lift here is bound to cause expensive damage by the back-ater. It is, however, not practicable to go much farther down the nyon for a site without coming within the limits of the pool of the m proposed by the Missouri River Power Company at Stubbs Ferry, miles below. Work has already been begun on the accessories of e latter dam.

A lift of 30 feet above the stage of the survey, or 31.6 feet above low ter, would give a backwater extending 7 miles upstream and flood-2,800 acres of land owned by private parties. The dam would be 0 feet long and would develop 11,850 horse power at low water.

A lift of 18 feet above the stage of the survey, or of 19.6 feet above w water, would give backwater flooding 1,820 acres owned by pri-te parties, and extending 5½ miles upstream. The dam would be out 380 feet long and would develop 7,350 horse power. In either se the weir should be next the left abutment and the lateral canal d lock next the right abutment.

Five of the sites described above are found on that portion of the er which is paralleled by the Northern Pacific Railroad. It would impossible to construct a dam at any of these which would not at site intrench upon the right of way of the road, which extends for 0 feet on each side of the middle line of the track.

The sites numbered 2, 3, 4, and 5 are located close together, the three t named being in the same canyon above Toston. They are to a tain extent alternative. With the lifts mentioned only two of them uld be occupied, as the dam at No. 5 would back the water beyond e site numbered 3, while No. 4 floods beyond No. 2.

The configuration of the ground at the sites in this canyon is such at the lifts could be considerably increased without proportional pense for construction and for damage, if an arrangement could be de with the Northern Pacific Railroad by which the track of the ter should be raised above the flood line.

For facility and economy of construction the site numbered 4 pos-sses the greatest advantages. A dam at site No. 6, being nearer elena, might be more of a success commercially. It would, however, ve to compete with the dam now projected at Stubbs Ferry, upon ich operations have already begun, and which is 6 miles nearer the y.

The act requires that the sites selected should be so located as not unreasonably impair the navigability of the river. A dam any-ere must be an effectual bar to navigation unless provided with a k or some substitute for the passage of boats. While there is no

commerce at present on this stretch of river, yet it has been reported as navigable and could probably be made available for boats drawing 30 inches were there a demand commensurate with the cost. It is, therefore, desirable to preserve the possibility of future improvement, and with this end in view to require that all proposed dams shall be located and constructed in accordance with plans approved by the Secretary of War, and in the selection of the location to insist upon provision for a lateral canal. The construction of the latter may well be left to the United States, but the right of way should be secured in the act authorizing the work.

The sites located by the present examination have a sufficient bench on the one side or the other to permit such construction.

Of the sum of $2,500, appropriated for this examination, there remains, after completion of the work, an available balance of $754.02.

The report of Mr. E. D. Vincent, assistant engineer, who was in charge of the local surveys, is appended.

Inch-mile maps Nos. LXXXI, LXXXII, and LXXXIII, and sheets 1, 2, 3, 4, and 5, showing the local surveys, are transmitted separately.*

Very respectfully, your obedient servant,

H. F. HODGES,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. EDWIN D. VINCENT, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *January 19, 1894.*

CAPTAIN: I have the honor to submit to you the following report of my examinations made during the months of September, October, and November last of the Missouri River between Three Forks, Mont. (near its head), and Canyon Ferry, covering a distance of some 81 miles downstream, the investigations being to determine and locate such places on this reach of river as would be favorable for the construction of dams, the purpose being to create water power for generating electricity.

This portion of the river is a clear, rapid stream. The width varies from 250 to 600 feet, the depth from 2½ to 25 feet, and the slope from 2½ to 7 feet per mile.

The volume of the discharge at extreme low water is 3,300 cubic feet per second and 4,015 cubic feet at mean water.

The sites selected are at places where the valley is narrow, the banks stable, and where the solid rock appears on one or both sides of the stream.

The surveys are connected with the secondary triangulation stations established by the Missouri River Commission, and also with the established Government section corners wherever the examined site comes within a subdivided district. The elevations are based on the sea-level datum.

In cross-sectioning the valley at the proposed sites, elevations were taken at intervals of 100 feet with such intermediate readings as were necessary to indicate the true contour of the ground. Soundings across the river channel were taken every 25 feet. In all cases the proposed locations contemplate the construction of a lateral canal, and lock to pass boats.

The sites are numbered consecutively from 1 to 6, beginning at the head of the river; plats and profiles of each accompany this report.

The plats show the position of the proposed dams with relation to the triangulation stations, and to the Government section corners wherever the latter occur; the location of the Northern Pacific Railroad, the areas covered by the backwater from the intended lifts, and the names of the property owners, if any, of the lands affected.

The profiles show the cross-section of the river at the sites examined, the character of its bottom and adjacent sides, and the calculated lifts, with their relation to

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* Not reprinted; printed in House Ex. Doc. No. 96, Fifty-third Congress, second session.

it water surface and to the base of rail of the Northern Pacific Railroad
s track, wherever its consideration is involved.
lso accompanies this report a profile* of the Northern Pacific Railroad
he series of canyons next above Toston; it represents the dam sites No.
d 5 and their respective lifts and flood lines with their relation to each
he base of rail of the railroad track and to the present water surface of
. The stations and mile posts on the railroad are also recorded, and, by
ot only can the sites already examined be readily relocated on the ground,
each of river can be studied with reference to a dam construction at any

also shown on this profile a suggested raise of the railroad track, extend-
from the dam sites Nos. 4 and 5, whereby the lift at these places might be
ter, and the horse power of the stream increased. This idea is referred to
he detailed descriptions of the sites that follow.
1 is located upon Northern Pacific Land Company's property at Eagle
iles below the head of the river; it is upon section 23, township 3 north,
st of the Montana principal meridian.
ock is a limestone cliff 30 feet high on the right bank of the stream; it
tly from the water, and therefore offers a very suitable abutment for that
e river.
k can be traced under the stream for 60 feet, where it is lost by being over-
a deposit of sand and gravel; this latter composes the bed for the remain-
way across the stream (550 feet).
e edge of water on the left bank to the rising ground (700 feet) the mate-
y or loam, with gravel underneath at a depth of 6 feet. The rising ground
l deposit.
onstructed at this point would be 1,450 feet long and the proposed lift 16
* * The lift would rise within 2.2 feet of the base of rail of the North-
c Railroad opposite the dam site; this would be the closest relation
he two, the track being on a continuous up grade.
d line would extend 3 miles upstream, and the area of the land covered
e river channel proper would be 34 acres, 12 acres belonging to the North-
c Land Company, and 22 acres to the Government. There are no actual
on this land to be affected.
mination marked as extra site on the map is upon the same property and
section as site No. 1, and is located 2,600 feet above the latter.
terial from the railroad track 325 feet to the water's edge is clay or loam,
xture of gravel; the river channel proper 300 feet across is sand and gravel
t back from the water's edge on the left bank a limestone cliff rises nearly
the material between the cliff and the water's edge is clay and broken
e proposed lift is 14.4 feet. * * *
d line would rise within 3 feet of the base of rail of the railroad opposite
ite; it would extend 2¼ miles upstream and would inundate 25 acres of land
e river channel proper; the area submerged would be comparatively the
at covered by the flood from dam site No. 1.
atest depth of water at this examination was 12.5 feet.
t this point would be 675 feet in length. This location will admit of a
onstruction than at site No. 1, although the permitted lift would not be

2 is located 3,700 feet below Painted Rock Station, on the Northern Pacific
it is upon unsurveyed territory, but should the land be subdivided it will
section 11, township 4 north, range 2 east of the Montana principal merid-
n would belong to the Northern Pacific Land Company, their grant from
Government giving them every odd section through subdivided territory.
terial on the right bank is clay mixed with bowlders and extends from the
feet to the water's edge; the bed of the river (370 feet across) is sand and
ering the bed rock to a depth of from 4 to 9 feet; 100 feet back from the
ge on the left bank the solid rock is met with, which rises nearly vertical
ght of 150 feet; the material between the water's edge and the cliff is clay
n rock.
t this point would be 750 feet long, it being necessary to carry the con-
from the cliff on the left bank up and through the railroad embankment
ht to the rising ground beyond.
nitted lift of 17.9 feet * * * would rise within 3 feet of the base of the
Northern Pacific Railroad, and 2,000 feet back would flood the track to a
.8 feet for a distance of 1,670 feet; this is at a place where the railroad
old bed of the river; it would not, however, be a serious matter, as the
d be raised along that distance at a small cost.

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* Not forwarded.

The flood line would extend 3½ miles upstream, and would flood 32 acres of land which, at present, belongs to the Government, with the exception of the regular right of way of 400 feet owned by the railroad company. The outcropping of rock at this place is a badly shattered granite; this defect would probably disappear with excavation.

Site No. 3 is located 2½ miles above Painted Rock Station, on the Northern Pacific Railroad, and 49¼ miles by rail from Helena; it is at present upon unsurveyed territory. Should the land be sectionized it would come within section 1, township 4 north, range 2 east of the Montana principal meridian, which would belong to the Northern Pacific Land Company.

The material on the right bank from the railroad, 265 feet to the water's edge, is a clay or loam mixed with gravel; the river channel proper, 275 feet, is loose rock and gravel, which covers the bed rock to a depth of from 2 to 10 feet. At the left bank the rock rises directly from the water to the height of 25 feet; it then breaks and joins the main cliff 30 feet back, which rises nearly vertical 150 feet. The rock is of volcanic origin and is of poor quality, being badly disintegrated along the exposed face of the cliff.

Investigations along the right bank adjacent to the railroad for a depth of 25 feet expose no rock foundation, and in all probability none would be found short of a level with the bed of the stream.

The total length of a dam at this site would be 440 feet. The proposed lift of 17.2 feet * * * would rise within 8.4 feet of the base of rail of the Northern Pacific Railroad opposite the dam site and 1 mile above, and would come within 3 feet of the base of rail in consequence of the grade of the track lowering upstream. The flood line would extend back 3 miles and would cover 28 acres of land outside the river channel. This land belongs to the U. S. Government, with the exception of the railroad company's right of way and a placer claim owned by Jacob Feishe. This claim, as shown on the plat with reference to the dam site, is situated between the Northern Pacific Railroad Company's right of way and the low-water edge of the stream; it extends along the river front for a distance of 1,300 feet. The proposed flood line from this site would extend back and beyond site No. 2, located 2 miles up the river.

Site No. 4 is located at the south end of the canyon next above Toston, and is 48.9 miles by rail from Helena. It is upon unsurveyed territory; should the land be subdivided it would fall upon section 7, township 4 north, range 3 east of the Montana principal meridian, which would be owned by the Northern Pacific Land Company.

The right bank from the railroad track 60 feet to the water's edge is rock in place; this rock can be traced under the stream for a distance of 125 feet to where it is covered by a deposit of loose rock and gravel, which composes the bed for 200 feet, the remainder of the way across; from the water's edge on the left bank to the cliff 250 feet distant, the material is clay and broken rock. The cliff on this side at the surveyed site has a 20-foot vertical face. A dam at this point would be 650 feet long. The rock at this site is a fine quality of quartzite.

The lift of 16.2 feet would rise 3 feet below the base of rail of the Northern Pacific Railroad; this would be the closest relation between the two, the track being on an up grade. The flood line would extend 2½ miles upstream, and would conflict with dam sites Nos. 2 and 3; it would cover 14 acres of Government land and would also affect Jacob Feishe's placer claim, mentioned in the description of site No. 3.

* * * * * * *

This site possesses the best natural advantages for the construction of a dam of any of the six examined; although the lift is not as great as at the other side and the distance across the opening greater than at some of them, it has the advantage of rock in place not only for the foundation of the dam but for both abutments. It was impossible with the appliances at hand to penetrate the débris and broken rock on the left bank to determine the depth to a solid foundation, but it is hardly probable that it would be farther down than to a level with the lowest point in the bed of the stream; in that case the greatest depth to bed rock would be 30 feet. If arrangements could be made with the Northern Pacific Railroad Company whereby their track could be raised 9 feet above its present level at this site, as shown and suggested on the accompanying profile, the lift could be increased to 25 feet. * * * This would necessitate the raising of the track over a distance of 12,000 feet to the average height of 4 feet. The area covered by the increased lift would be comparatively little more than from a 16-foot head and the increase of damage aside from that sustained by the railroad company's property would be nothing.

Site No. 5 is located at the north end of the canyon, 3 miles above Toston, on the Northern Pacific Railroad, and is 47 miles by rail from Helena. This place offers a very suitable location for a dam; it is upon unsurveyed territory, but the site at present is occupied on the right bank by the right of way of the Northern Pacific Railroad, they having 200 feet each side of the center line of the track, and the left bank is taken up and recorded by Frank Belden as a placer claim. Should the land

ided this location would come within section 6, township 4 north, range 3
ie Montana principal meridian. The right bank from the railroad, 200 feet
ater's edge, is clay mixed with gravel; the bed of the river, 280 feet across,
ock, covered for the first 150 feet with loose rock and gravel to a depth
to 5 feet; the remainder of the way over the solid rock is clear of débris,
exception of isolated bowlders.
ff rises vertical 30 feet back from the water's edge on the left bank; it is a
quality of quartzite, the same formation as the rock at site No. 4. The
this vicinity is broken up in a series of rapids, the most pronounced of any
each of river; the slope from the site is 7 feet for the first mile above, and
f the stream is strewn with large rocks and bowlders. The rock is of very
haracter, the rush of water seeming to have had but little effect upon it, for
ion of the river bears the same characteristics now as those described by
d Clarke at the time of their passage during the summer of 1805.
oposed dam at this place would be 550 feet in length, and with the admitted
feet * * * the flood line would conflict with dam sites Nos. 3 and 4.
would rise within 3 feet of the base of rail of the railroad track opposite

would be very little land submerged by a dam constructed at this point;
ges to be determined would be upon Belden's placer claim and that sus-
the Colorado and Montana Hydraulic Mining Company, who own a mile
lown the river, extending from the bluff to low-water mark and located
rence to the dam, as shown on the plat; there is also an irrigation ditch
g from the big spring down along the right bank adjacent to the railroad
ld be destroyed and would come into consideration.

* * * * * *

night also be projected from a dam at this site, or from the one next above,
of irrigation whereby the large valley immediately below, extending some
lown the river, could be reclaimed, whereas at present but a fraction of
is under cultivation.
. 6 is located at Canyon Ferry, and is distant from Helena 18 miles by wagon
is situated upon the property of Court Sheriff, in section 10, township 10
nge 1 west of the Montana principal meridian.
right bank the cliff rises 100 feet back from the water's edge; the material
is clay mixed with bowlders, with solid rock 10 feet underneath; across the
nnel proper, 260 feet, the bottom is sand and gravel; at the water's edge on
ank the cliff rises on a slope of 1 to 1 to a height of 200 feet. The greatest
water at this cross section is 17.2 feet. The distance across the opening
to cliff is 400 feet.

* * * * * *

od from the proposed lift of 30 feet would extend 7 miles upstream and
ver outside the river channel proper 2,800 acres of land owned by actual
this amount includes the islands in the river within section 14, homesteaded
lls.
nd is all within the valley proper and is quite valuable, being cultivated
extent, but used principally for pasturage and raising hay. * * * The
from the suggested lift of 18 feet at the same site would extend back 5¼
l would submerge 1,820 acres of land outside of the river channel proper.
ritory to be affected by the backwater from these proposed lifts is shown
aps, with the land divided and described according to the present owner-

te, with the exception of the large area that would be covered by the back-
fers a very suitable location for a dam; the rock, which is of a very fine
f granite, not only offers natural abutments for both sides of the river,
ormation is so located that quarries might be easily opened, whereby the
for the entire construction would be furnished on the ground.
here no provision made for a lateral canal and lock to pass boats, a dam
constructed 300 feet above this proposed location, whose total length
but 230 feet.
gh the kindness of Mr. William Muth, secretary of the Missouri River
ompany, of Helena, Mont., I am enabled to hand you herewith the maps
les * relating to the company's intended dam across the Missouri River near
'erry: also the very complete reports from their resident and consulting
on the cost of the construction of the dam proper, the power house, tun-
, with an estimation of the horse power of the stream to be developed from
nded lift of 30 feet.

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* Not forwarded.

The proposed location of this dam is 2.6 miles below Stubbs Ferry, the latter being 12 miles from Helena by wagon road.

The flood line from this dam will extend 7½ miles up the stream, or within 1 mile of Canyon Ferry. The lands to be affected are owned principally by the power company.

Very respectfully, your obedient servant,

EDWIN D. VINCENT,
Assistant Engineer.

Capt. H. F. HODGES,
Corps of Engineers, U. S. A.

A A 4.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

APPROVED PROJECT.

The approved project contemplates rock removal at various places on the river, the construction of closing dams and wing dams at points below Glendive, and a survey of the river. Operations under this project are now suspended.

APPROPRIATIONS.

1878 (allotment for survey from appropriations for examinations and surveys)	$15,000
1879	25,000
1880	15,000
1881	20,000
1882	20,000
1884	20,000
1886	18,750

CONDITION AT BEGINNING OF YEAR.

The expenditures on the river have resulted in giving a depth of 3 feet at the points improved above Glendive, and of 3 feet or more at the points improved below that place. The survey has been finished.

OPERATIONS DURING THE YEAR.

During the fiscal year ending June 30, 1894, no work was done. For reasons given in Appendix X 2 of the Annual Report of the Chief of Engineers for 1887, the project is suspended for further action of Congress.

There has been expended on the river improvement a total sum of $103,029.42, and on the survey a total sum of $19,000.

There was formerly a brisk river traffic, which has been killed by the railroads.

Money statement.

July 1, 1893, balance unexpended	$11,720.87
June 30, 1894, amount expended during fiscal year	.29
July 1, 1894, balance unexpended	11,720.58
July 1, 1894, outstanding liabilities	.17
July 1, 1894, balance available	11,720.41

APPENDIX B B.

IMPROVEMENT OF OBION RIVER, TENNESSEE, AND OF CUMBERLAND RIVER, TENNESSEE RIVER ABOVE CHATTANOOGA AND BELOW BEE TREE SHOALS, AND THEIR TRIBUTARIES, TENNESSEE AND KENTUCKY.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Obion River, Tennessee.
2. Tennessee River above Chattanooga and below Bee Tree Shoals.
3. Hiwassee River, Tennessee.
4. French Broad and Little Pigeon rivers, Tennessee.
5. Clinch River, Tennessee.
6. Cumberland River, Tennessee and Kentucky.
7. Caney Fork River, Tennessee.

UNITED STATES ENGINEER OFFICE,
Nashville, Tenn., July 18, 1894.

GENERAL: I have the honor to transmit herewith the annual reports upon the river improvements in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

JOHN BIDDLE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

B B 1.

IMPROVEMENT OF OBION RIVER, TENNESSEE.

The Obion River flows wholly in the State of Tennessee, and is a tributary of the Mississippi River, which it enters about 1 mile above Hale Point.

This stream is formed by the junction of the north and south forks in the western part of Tennessee, and flows in a generally southwesterly direction for about 75 miles to the Mississippi. In its course the Obion receives the overflow from Reelfoot Lake and, about 4 miles above its mouth, the waters of the Forked Deer River. At Obion the

river is crossed by the bridge of the Newport News and Mississippi Valley Railroad, which has no draw, and consequently forms an obstacle to navigation above that town.

An examination of this stream was made in 1880. (See Report of the Chief of Engineers, 1881, pp. 1486–1489.) An instrumental survey was made in 1891 from the Railroad bridge at Obion to the mouth of river, a distance of 68.8 miles, having a fall of 27 feet.

The course of the Obion is through a low, alluvial, and well-timbered country, subject to overflow, due, in a great measure, to backwater from the Mississippi. It has a width varying from 80 to 200 feet, and a depth generally of over 5 feet at low water, except at certain shoals, where in some places a depth of but 13 inches was found. The shoals are usually caused by obstructing driftwood, which holds sediment in place, and it is thought that the removal of the drift will aid in the removal of the shoals. The river is also greatly obstructed by snags and overhanging trees. The tortuous course of the river is a source of difficulty, some of the bends being very sharp, forming loops with narrow necks. At some of these points it might be well to make "cut-offs." There is but little current to contend against. As far back as 1843 surveys were made by the State of Tennessee and considerable work done by the State in clearing the river of surface obstructions, but the advantages gained were but of temporary duration.

The project for the improvement, based upon the survey of 1891 and the estimate of $50,000, consists of clearing the channel of snags, drift, and overhanging trees; constructing wing dams at the most obstructive shoals; straightening the very tortuous channel by cutting through several sharp bends and making the cut-offs sufficiently wide and deep by clearing, grubbing, and excavating; closing the old channel by means of pile and brush dams in order to secure at low water a navigable channel of not less than 3-foot depth between Obion and mouth of river.

The only appropriation by Congress for improving the Obion River, Tennessee, was that made by act of July 13, 1892, $7,500.

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1893, was $5,466.99, which has resulted in obtaining comparatively safe navigation for small steamboats. The channel has been greatly improved by the removal of surface obstructions between Lane Ferry and Obion, Tenn., a distance of about 22 miles; the stretch of 10 miles from Obion to Sharpes Ferry has been carefully worked over a second time and very satisfactory results attained. In May, 1893, a small steamboat with two loaded barges passed up from Mr. C. A. Fleischhauer's lumber mills, near Lane Ferry, to Obion. This was the only boat passing up during the last fifty years.

Work in channel was resumed in September of this fiscal year and continued until the close of November when active operations were suspended, high water having set in and the funds available being nearly exhausted. In the stretch of about 20 miles of river below Obion the channel was again worked over, removing more completely the drift gorges forming the principal obstruction to navigation. The following work was done, viz: 890 snags, 689 sunken logs, 617 cords of drift, 71 cords of brush, and 18 fallen trees removed; 705 snags topped; 389 cords of drift burned; 177 overhanging trees felled, 56 deadened, and 6 topped; 554 logs were pinned to the banks to prevent them being carried into the channel at flood stages.

The amount expended, including outstanding indebtedness, during the fiscal year, was $1,809.69.

The commerce of this river is principally lumber, cut by the seven sawmills now in operation on or near this stream.

Estimate of cost of improving Obion River, Tennessee	$50,000.00
Amount appropriated	7,500.00
Amount expended, including outstanding indebtedness	7,264.68

Money statement.

July 1, 1893, balance unexpended	$2,045.01
June 30, 1894, amount expended during fiscal year	1,797.69
July 1, 1894, balance unexpended	247.32
July 1, 1894, outstanding liabilities	12.00
July 1, 1894, balance available	235.32
Amount (estimated) required for completion of existing project	42,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Obion River, Tennessee, from July 1, 1893, to June 30, 1894.

	Tons.
Lumber	12,000
Logs	4,000
General merchandise	200

B B 2.

IMPROVEMENT OF TENNESSEE RIVER.

(Length, 673 miles.)

The junction of the Holston and French Broad rivers, 4½ miles above Knoxville, is now generally taken as the head of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the fifty-three or more tributaries of the Mississippi River, the Tennessee has always held an important place in the projects for the improvement of the navigable waterways of the country. The Muscle Shoals Canal having been opened to navigation, the Tennessee River is now navigable from its source to its mouth, a distance of 673 miles, during several months of each year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river, so as to make navigation continuous throughout its entire length for boats of moderate draft, is by no means an impossibility.

1. ABOVE CHATTANOOGA (188 MILES).

This section of the river is navigable during medium and high stages, which usually prevail through the winter and spring months, and occasionally at other seasons during the occurrence of co-called rain tides.

The navigation consists of steamboats carrying freight and passengers, flatboats bringing products from the upper tributaries, and rafts of logs and lumber, also brought from the tributaries, the latter constituting the major part of the commerce of the Upper Tennessee River.

In 1830 Col. S. H. Long, U. S. Topographical Engineers, made a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line. His report, published as House Ex. Doc. No. 167, Forty-third Congress, second session, gives a detailed description of every obstruction to navigation at that time, and plans and estimates for their improvement. In 1871 an examination was made between Knoxville and Chattanooga by Capt. L. Cooper Overman, Corps of Engineers, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of Chief of Engineers, 1871, pp. 502–507, and 1872, pp. 488–494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with lengths varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water and the current varying from 2½ to 6 miles per hour.

The bed and banks of the river are of such character as to make any improvements more or less permanent, with the exception of the removal from time to time of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams, but there is no record of the work done, and it did not prove of lasting value.

In 1850 Congress appropriated $50,000 for the improvement of this portion of the river, and the money appropriated was expended under the direction of Col. J. C. McClellan, Topographical Engineers, U. S. Army. Some of the dams built under this appropriation are still in existence, though generally covered up by the more extensive work of recent improvements.

The present project of improvement is based upon the examination of 1871, and provides for the removing of snags and drift, and for deepening the channel at the worst obstructions by blasting and dredging, or by scouring the bars by the aid of wing dams to an extent that will secure a channel 3 feet in depth at average low water, and at an estimated cost of $340,000. The estimate of 1871 was increased in 1874, 1877, 1884, and 1891 for the reasons stated in the reports of those years.

Under the provisions of the river and harbor act of September 19, 1890, a "careful and comprehensive survey" of the Tennessee River above Chattanooga was made "with a view of ascertaining to what extent the navigation of the river is capable of improvement, and the cost of the same, and the preparation of suitable plans therefor." This survey was begun in May, 1891, and completed during the fiscal year 1893. The report, with estimate and plans, was submitted to the Secretary of War in February, 1893, and forms House Ex. Doc. No. 252, Fifty-second Congress, second session. The plan of improvement proposed is the same as that now in progress, as above stated; that is, to obtain a 3-foot low-water navigable channel between Chattanooga and the mouth of the French Broad River, at an additional estimated cost of $650,000, the balance of the former estimates, $44,000, being wholly inadequate for the purpose, as can be readily seen by reference to the survey reports, forming part of annual report upon the improve-

) Tennessee River, 1893. If the present project—that of foot low-water navigation—is to be carried out, a revision ıate of cost must of necessity be made in accordance with ven in the survey report of February, 1893, submitted to r its consideration.

and harbor bill now pending in Congress appropriates e expended in accordance with the project submitted Feb- 893, that of obtaining a 3-foot navigable channel at low) Chattanooga. Should this project receive Congressional d this sum be made available, then, upon the approval of ' Engineers, the revised estimate of $650,000 will be sub- the balance of the old estimate, the $44,000 herein reported. ıt of such legislation, the amount that can be profitably the fiscal year ending June 30, 1896, would be $65,000. ppropriations have been made by Congress for this work, ; the sum of $296,000, viz:

		Act of—	
870	$35,000	March 3, 1881	$7,000
872	25,000	August 2, 1882	7,000
873	25,000	July 5, 1884	3,000
874	25,000	August 5, 1886	7,500
875	40,000	August 11, 1888	15,000
, 1876	15,000	September 19, 1890	30,000
878	15,000	July 13, 1892	25,000
1879	11,500		
880	10,000	Total	296,000

nt expended, including outstanding indebtedness, to June s $291,944.05. This expenditure has resulted in giving a season of navigation and an improved channel at 29 of the ons enumerated by Col. Long in his report of an examina- ı 1830. Operations have consisted generally of excavating avel from the channel and building stone dams where neces- increased depth over reefs and shoals. It is reported that ne at White Creek Shoals was rendered specially advan- causing the removal of the sand bar to deep water, "and it hat it is not likely to re-form for many years in the navi- el." The channel and reefs at Soddy Shoals were examined ogress made in drilling and blasting the rocky ledges form- truction; the work is giving satisfaction to the navigation Work was also resumed at Caney Creek Shoals by opening he south bank at head of shoals and quarrying stone for the prap dams.

/ Creek Shoals the quarrying of stone for dams was con- July 10; quarry stripped, 213 cubic yards, and stone quar- bic yards, being the only work done during the present

ıs were suspended in July, the stage of water not being low to permit of carrying on the work to advantage. The ce, with the necessary boats, etc., was then moved to the ad River, and it was not found expedient nor economical ıited amount of funds available to resume active operations r Tennessee during the present fiscal year. The boats, with ngineer property, were dropped down to Chattanooga and are of watchmen as a measure of economy and safety. y authority of the Chief of Engineers, the steamer *Stephen* l two quarter boats were taken to the Cumberland River for

temporary use, to be returned when work is resumed on the Tennessee River.

The amount expended during the fiscal year, including outstanding indebtedness, was $5,920.48.

The amount available and the balance of the estimate heretofore submitted can be profitably expended during the fiscal year 1896 in prosecuting the work under the project for obtaining a 3-foot navigable channel at low water between Chattanooga and the mouth of the French Broad River, by continuing channel work at Caney Creek Shoals and at such other obstructions as may be hereafter selected.

The estimates for improving Tennessee River above Chattanooga amount to	$340,000.00
Amount appropriated	296,000.00
Amount (part) received, sale of steamer *McPherson*	2,400.00
Amount expended, including outstanding indebtedness	295,752.90

Money statement.

July 1, 1893, balance unexpended	$8,567.58
June 30, 1894, amount expended during fiscal year	5,823.41
July 1, 1894, balance unexpended	2,744.17
July 1, 1894, outstanding liabilities	97.07
July 1, 1894, balance available	2,647.10
Amount (estimated) required for completion of existing project	44,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	44,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

2. BELOW BEE TREE SHOALS (225 MILES).

Information pertaining to the section of the river below Bee Tree Shoals (Riverton, Ala.,) is very limited. In 1864–'65 a reconnoissance of the Tennessee River from Paducah to Florence (225 miles) was made by a party of the U. S. Coast Survey, the data thus obtained to be for the use of the Mississippi squadron under the command of Acting Rear-Admiral S. P. Lee, U. S. Navy. The "notes" pertaining to the map of the survey states that—

> The stages of water in the Tennessee may be divided into low, ordinary, and high water. A low stage of water prevails under usual circumstances for three months of the year; a medium or ordinary stage lasts, generally, five months, and a high stage four months.
>
> The average depth of the river at a low stage is, on all the bars, 3½ feet, excepting Duck River Shoals and Big Bend Shoals, on which 6 inches less is found at such a stage. This applies, however, only to the river below Chickasaw. The average depth at a medium stage may be considered 9 feet on the bars. At this stage only the Green Bottom Bar is bare.

Green Bottom Bar, Duck River Shoals, and Big Bend Shoals, above referred to, are distant 88 miles, 108 miles, and 199 miles, respectively, from mouth of river. Chickasaw Settlement, 225 miles, is now known as Riverton, Ala. This section of the river has been heretofore covered by the surveys, estimates, and appropriations for the Tennessee River below Chattanooga, and no special allotments were made for the river below Bee Tree Shoals from the allotments for the Tennessee River made from the general appropriation acts of 1868 and 1869 and the appropriations from 1870 to 1892, inclusive, aggregating the sum of $4,183,000.

rvey was completed in December, 1867, from Chattanooga to of river, and an estimate of $40,000 submitted for removal of ctions and construction of wing dams below Florence, 255 miles. t of Chief of Engineers, 1870, p. 389.)

Walter McFarland, Corps of Engineers, speaking of the Lower ssee, in his report on lines of water communication between the ssippi River and the Atlantic (Report of Chief of Engineers, 1872, , states that—

nding the river we find that improvements of some kind or other—removing gravel or constructing wing dams, in order to straighten or widen the chan- o give them sufficient depth—will be required at the following points, viz: eek Shoals, Indian Creek, Big Bend Shoals, Diamond Island, Wolf Island, luff, Beech Creek Shoals, Buffalo Shoals, Armstrongs Towhead, bridge at ville, Duck River Shoals and Suck, Turkey Island Shoals, White Oak Harrican Island, Leatherwood Shoals, Sandy Island, Panther Creek Island, ughs Bar, Blood River Island, Pentecost Towhead, Widow Reynolds Bar, Towhead, Little Chain, and Grand Chain.

878 and 1879 some work was done at Duck River Shoals, 117 elow Bee Tree Shoals. This shoal is a gravel bar, and is subject siderable change from the action of the current. In 1881 and n 1890 a small force with a snag boat was employed a short time a year removing from the channel a large number of snags and nging trees. In 1882 the following localities below Rockport, 4 miles below mouth of Duck River, were reported as requiring rement: Duck River Suck, Johnsonville, Reynoldsburg Island, y Island, Sandy Island, Little Chain, and Big Chain. It is stated Annual Report of the Chief of Engineers, 1892, p. 1915, that—

g the last fifteen years the improvement of the river below Bee Tree Shoals, act below Florence, has not received the attention its commerce and navi- appears to be justly entitled to, owing to the almost imperative necessity of rating all efforts and expending all moneys appropriated for the river Chattanooga" upon the removal of the main obstruction to navigation, until r the impassable barrier of the Muscle Shoals. However, during that fifteen small amount of work was done, as above stated, below Riverton, foot of e Shoals, Alabama.

and 1879, in the channel at Duck River Shoals, amounting to	$7,304.95
and 1882, snagging, etc	3,373.04
snagging, etc	1,365.33
otal below Bee Tree Shoals from 1875 to 1891	12,043.32

ie reasons stated and from information received from various sources, it is l that the condition of the Lower Tennessee demands an accurate survey. iscle Shoals Canal, opened to navigation November 10, 1890, and the work progress at Colbert Shoals and Bee Tree Shoals, make it very important that ver Tennessee River, from the foot of Bee Tree Shoals to the mouth of the e put in such condition as to permit the safe passage at all seasons of any apable of navigating the Muscle Shoals Canal and the proposed Bee Tree bert Shoals Canal now in course of construction. In order to accomplish vill be necessary to have an instrumental survey made of this section as possible, to obtain detailed maps of the obstructions, with a complete profile iver, so that estimates can be made and project for the radical improvement river below Riverton, Ala., be submitted, based upon the necessary and data that can only be thus obtained.

e Tennessee below Bee Tree Shoals is to be radically improved it is very ry, as above suggested, that an instrumental survey be made as soon as ible, for the reason that the surveys, so called, heretofore have been rapid issances or examinations, and do not furnish the data necessary whereon to economic, advantageous, and energetic prosecution of any work of improve- at may be projected.

LIVINGSTON POINT, KENTUCKY.

The Annual Report of the Chief of Engineers, 1892, p. 1916, describes Livingston Point as follows:

This is a narrow strip or tongue of land lying between the waters of the Ohio and Tennessee Rivers, just above the mouth of the latter stream. This point and two small islands below it form the harbor of Paducah, and by their position prevent the ice-bearing current of the Ohio from entering the harbor, which is supplied with the warmer waters of the Tennessee flowing from a southern latitude and rarely if ever troubled by ice.

The currents of the two streams are parallel for about a mile on either side of Livingston Point, and the Ohio River is rapidly encroaching upon this narrow barrier. The Tennessee River does but little damage. Near the extreme end of the point the Ohio has washed through at high water.

Allotments from the appropriations for improving Tennessee River below Chattanooga, to be used at Livingston Point, Kentucky, at the mouth of said river, have been made as follows:

Amount allotted:	
Act of September 19, 1890	$25,000
Act of July 13, 1892	25,000
Total	50,000

A survey of Livingston Point was made in December, 1890, and based upon the data thus obtained a project for its preservation, with an estimate of $180,000, was submitted January 12, 1891, to the Chief of Engineers, which was approved by the Secretary of War on the 16th of the same month.

As stated in report of Chief of Engineers, 1891, p. 2256—

The plan of improvement adopted for preserving this point from destruction consists in covering the wearing slopes with a revetment of stone and brush carried well down the bank below the water surface, supplemented by a pile and stone dike along the crest of the weakest portion of the line, where the current of the Ohio has already cut through at high stages of the river, the object of both works being to hold in its present position the land now existing, and to cause, if possible, a further deposit of sediment on the Tennessee side of the dike, which from the present indications is likely to occur.

The revetment of stone and brush is specially needed on the Ohio side and will be but sparingly required on the Tennessee side. It will be carried well below low water, where it will consist of brush weighted down with stone in alternate layers. From low water to foot of dike broken stone will be carefully placed.

The amount expended, including outstanding indebtedness, to the close of the fiscal year ending June 30, 1893, was $24,423.59, which has secured the completion of the dike on the Ohio side across the "washout" near the extremity of the point for a distance of 660 feet, and the protection of the bank for a length of 2,330 feet, extending 632 feet above the dike and 1,038 feet below it, the average width being 47 feet, all the work being done on the bank facing the Ohio river so as to protect at once the low part of the exposed strip or "point," which was in danger of washing away. The work under contract for the shore protection of the Ohio bank of Livingston Point, by building a revetment of brush and stone riprap was carried on in December, 1892, and April, 1893, 2,000.4 cubic yards of stone being placed in position at the close of the fiscal year 1893.

The work of protecting the Ohio bank was continued under contract during July, August, and September of present fiscal year, 7,091.53 cubic yards of stone, at $1.23 per cubic yard, and 273.75 cords of brush, at 94 cents per cord, being used for that purpose, at the aggregate cost of $8,979.90. This contract was completed and terminated November 9, 1893, in accordance with its terms.

During an examination of Livingston Point in July it was found that unusually heavy ice and high water had greatly injured the point by causing the wearing away of the Tenessee bank to an alarming extent; it was recommended that the Tennessee bank be also suitably protected by stone riprap; this work was approved, and authorized to be done by hire of service, and purchase of materials in open market. During the months of August, September, 1893, and January, 1894, 9,116.48 cubic yards of stone were placed as riprap protection to the Tennessee bank at a cost of $1.23 per cubic yard, $11,213.26.

Total amount expended, including outstanding indebtedness, during the fiscal year was $23,804.68.

Having reference to the bridges spanning the Lower Tennessee River, of which formal complaint has been made and action taken by the Secretary of War—

(1) The removal of the rest piers of the bridge of the Newport News and Mississippi Valley Company at Gilbertsville, Ky., is reported by said company as completed. By direction of the Secretary of War the rest piers were to be wholly removed to a depth of not less than 6 feet below extreme low-water mark. The said company reports that the piers "have been removed to a depth of 6 feet or more below extreme low water," but verification by the engineer officer in charge was not practicable before submission of this report, it being necessary to wait for a "low-water" reading of the guage, there being great uncertainty as to its reading at the time when the examination was made.

(2) The bridge of the Nashville, Chattanooga and St. Louis Railway at Johnsonville, Tenn., having been reported upon as an unreasonable obstruction, owing to the faulty construction of the draw and the large deposits of stone placed around the piers to strengthen them, an alteration of the obstructing bridge was taken under consideration by the War Department. The plan for the modification of the existing structure was approved by the Secretary of War. The alterations in said bridge have been completed, and the abandoned piers and riprap in the draw spans have been removed in accordance with the approved plans and report to that effect rendered to the Chief of Engineers, April 6, 1894.

No survey has been made of the Tennessee River below Bee Tree Shoals, nor project or estimate submitted for its improvement.

The balance of the estimate for work under the existing project, $130,000, can be profitably expended in continuing the construction of the dike, and revetment of both banks of Livingston Point where found to be necessary.

Estimate of cost of preserving Livingston Point, Kentucky	$180,000.00
Amount appropriated by allotment	50,000.00
Amount expended	48,228.27

Money statement.

July 1, 1893, balance unexpended	$25,576.41
June 30, 1894, amount expended during fiscal year	23,804.68
July 1, 1894, balance unexpended	1,771.73
Amount (estimated) required for completion of existing project	130,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	130,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Tennessee River above Chattanooga, Tenn., from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Grain	18,793	Shucks	167
Iron ore	11,988	Bricks	160
Coal	10,202	Horses and mules	152
Corn	6,327	Sewer pipe	120
Lumber	3,212	Tobacco	93
Hay	1,880	Cross-ties	88
Sand	1,763	Peas	51
Tan bark	800	Straw	46
Flour	644	Guano	23
Oats	408	Chickens	12
Wheat	383	Onions	9
Hogs	376	Eggs	3
Salt	276	Butter	3
Shingles	252	General merchandise	12,560
Wood	225		

List of steamboats (stern-wheel) plying on Tennessee River above Chattanooga, Tenn.

Name.	Length.	Breadth.	Depth.	Tonnage, net.
	Feet.	*Feet.*	*Feet.*	
C. M. Fouche	93	14	2	61.13
Dayton	142	24.7	3.8	195.63
J. R. Hughes	98	17	3.5	95.15
J. C. Warner	142	31.6	4.6	201.05
J. W. Bussell	76	9	2.8	24.60
Lucille Borden	86	14	2.5	55.32
Oliver King	60	8	2.6	29.30
R. C. Gunter	153	28	4	337.30
Rockwood	130	25.6	4	150.32
R. T. Coles	118	24.6	4.2	134.91
Tallassee	60	12	2	22.16
Plucky City	.....	22	3	79.65
Kingston	.....	11	3	37.00
Onega	.....	18	2.5	74.77
Ocoee	.....	12.5	1.6	19.13
Wyeth City	120	21.5	.....	138.96
Walter R. Love	112	18	3	80.14
Clinton B. Fisk	100	18	2.4	78.00
Key City	80	15	3.2	59.65
Maud	79	16.5	3.2	25.30
J. P. Kendrick	112	20	3.7	125.71
Ruth Dodd	37.5	7	2.8	11.13
Vollette	45	8	3	15.5
Verona	43.2	11	2	6.13
Harriman	30	7.5	4	5.93
John A. Hart	41	7	2.1	5.63

Tennessee River below Chattanooga, Tenn.—Below Bee Tree Shoals, Riverton, Ala., from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Ties	146,040	Salt	700
Coal	22,331	Peanuts	506
Logs	18,260	Hogs	200
Lumber	17,945	Bricks	115
Staves	12,815	Tobacco	110
Grain	7,015	Shingles	100
Flour	4,171	Wood	61
Cotton	1,631	Horses and mules	30
Cattle	1,020	General merchandise	19,343
Hay	800		

mboats (stern-wheel) plying upon Tennessee River below Chattanooga, Tenn.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Net.*
.....	83.6	17.6	3.25	35.96
in.....	149	31	4	318.46
.....	132	29	3	226.39
.....	200	35	6	576.86
ih.....	190	34	3.5	318.91
iah.....	186	31.2	5.3	335.55
i.....	180	35	5.3	329.74
.....	91	18	3	65.94
s	153	20.5	3.2	132.99
.....	46.5	8.4	4.6	13.39
.....	53	12	3	9.16
.....	50.6	9.2	2.8	7.61
.....	124	22	4.2	140.57
ibb.....	112.9	24.7	3	98.7
.....	69	14	3	36.54
nooga.....	148	30	4.5	261.89
.....	109.9	19	3	55.95
.....	.....	16	3.5	63.86
.....	49	12	3.5	16.19
.....	85	15	3	37 73
.....	106.2	33	5.2	153.08
.....	96	17.4	3.9	76.84

B B 3.

IMPROVEMENT OF HIWASSEE RIVER, TENNESSEE.

vassee River rises in the Blue Ridge in western North Car-northern Georgia, and flowing in a west-northwesterly direc-s the Tennessee River about 35 miles above Chattanooga and below Knoxville. After breaking through the Smoky Moun-and receiving the waters of the Ocoee, near Columbus, the becomes a stream of good capacity for navigation.

y as 1830 the State of Tennessee made some minor improve-; the work was only of temporary advantage. The act of of June 23, 1874, authorized an examination of this river. nation was made in September, 1874, under the direction of er McFarland, Corps of Engineers. (See Report of Chief of , 1875, pp. 809–813.) The principal obstructions were found reefs, gravel bars, snags, and overhanging trees, and are of general character as those of the Upper Tennessee, and the f the river is equally permanent.

ject for the improvement was based on this examination, and in narrowing the waterway by wing dams at the shoal places ating rock reefs and gravel bars so as to secure a navigable feet wide and 2 feet deep at ordinary low water to Savannah at 43 miles from mouth of the river.

ginal estimate submitted in 1875 was increased from 1878 to sive, to $36,500, which amount has been covered by the ten ions made for this improvement, viz:

		Act of—	
14, 1876	$10,000	July 5, 1884	$2,500
1878	10,000	August 5, 1886	2,500
, 1879	3,000	August 11, 1888	1,000
1880	3,000	September 19, 1890	1,500
, 1881	1,500		
2, 1882	1,500	Total	36,500

opriation was made for this river by act of July 13, 1892.

unt expended to June 30, 1893, including outstanding indebt-s $36,449.89.

The annual reports for 1892 and 1893 state that—

The work has resulted in a partial improvement of the lower river, securing an increased depth of channel and the removal of surface obstructions and overhanging trees.

The work was done at different times at the following obstructions: Matthew Shoals, McElrath Shoals, Sivils Shoals, Magills Islands, Blackbird Shoals, Graves Ferry and Shoals, Canefield Reef, Lasters Creek Shoals, Brindley Shoals, Denton Island Shoals, Boyd Shoals, Horseford Shoals, and Gamble Shoals. The Hiwassee is now navigable for steamboats from its mouth to Charleston, 21 miles, during the boating season on the Upper Tennessee River. Above Charleston to Savannah Ford flatboats are used for transportation.

The work was first begun in June, 1877, at Matthew Shoals, and at intervals since, as each appropriation became available, efforts have been made to improve the channel at this the principal obstruction to navigation.

In order to distribute the fall at these shoals a part of the main dam extending from the right bank, opposite the lower island, was removed, and a new spur dam, 167 feet long, built on a reef extending from the north bank, was constructed to back up the water. The effect has been very satisfactory to the extent of securing a reduction of the current's velocity opposite the lower island, but owing to high water and the exhaustion of the appropriation it was not practicable to complete the much needed work. The other dams were straightened, raised, or strengthened where necessary; the banks also were protected by felling trees and placing brush in position, anchoring the same with stone; this resulted as desired in protecting the bank and deflecting the current to the opposite side of the river. A ringbolt was securely placed in position on end of lower dam to assist heavily laden ascending boats.

Work was suspended in September, 1892, the funds available for active operations being then exhausted.

The amount expended during the fiscal year, including outstanding indebtedness, was $23.26.

Boats belonging to the Tennessee River Transportation Company ply upon this stream during the season of navigation. Small boats of about 100 tons capacity can navigate the Hiwassee River about eight months in the year.

The estimates of cost of improving the Hiwassee River have been appropriated and expended. If it be determined to do further work upon this stream, it would be advisable that an instrumental survey be made to obtain accurate data whereon to base a project and estimate for the radical improvement from its mouth to Savannah Ford. This stream, in common with other mountain streams of this section, requires that the channel be kept clear of snags, logs, etc., brought down by the annual floods, and it is advisable that provision be made for such work, so that the advantages resulting from previous expenditures can be maintained.

Estimate of cost of improving Hiwassee River, Tennessee	$36,500.00
Amount appropriated	36,500.00
Amount expended, including outstanding indebtedness	36,450.11

Money statement.

July 1, 1893, balance unexpended	$73.15
June 30, 1894, amount expended during fiscal year	.23
July 1, 1894, balance unexpended	72.92
July 1, 1894, outstanding liabilities	23.04
July 1, 1894, balance available	49.89

COMMERCIAL STATISTICS.

Hiwassee River, Tennessee, from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
.....	3,600	Guano.....	22
.....	1,218	Eggs	10
.....	275	Sand	6
.....	118	Oats.....	5
.....	69	Chickens.....	4
.....	65	Butter.....	1
.....	55	Salt	1
.....	52	Straw	1
.....	44	Bran	1
.....	31	General merchandise.....	1,114

B B 4.

VEMENT OF FRENCH BROAD RIVER AND LITTLE PIGEON RIVER, TENNESSEE.

French Broad River is one of the largest tributaries of the Ten-
. This stream has its source in North Carolina, on the western
of the Blue Ridge, enters the State of Tennessee at Paint Rock,
ter a course of 121 miles unites with the Holston River 4½ miles
Knoxville, thus forming the Tennessee River.

appropriation was made by the State of Tennessee about fifty-
ears ago for the purpose of improving the rivers of the section
nown as the "East Tennessee District," and the improvement of
Islands Shoals of the French Broad River, about 30 miles below
idge, was begun under direction of commissioners appointed by
tate. The State of Tennessee also built some dams above Dan-
, but these, with the exception of a few repaired by the United
in 1881, have been removed during the progress of the work
the present project.

examination was made of the French Broad in Tennessee, under
ity of act of Congress, July 11, 1870, and the report upon it is
found in the Report of Chief of Engineers for 1871, pp. 491–494.
xamination in Tennessee was ordered by Congress, in act of March
, "from its junction with the Holston, at Knoxville, to Leadvale,
" The estimate made in 1871 was resubmitted with the report of

ow Leadvale—mouth of Nolichucky River—a distance of 90 miles,
ver is impeded by the surface obstructions usually found in
ain streams. This stretch of river is exceptionally beautiful,
, and adapted to navigation, especially below Dandridge, about
es. The fall being only about 1 foot per mile, the channel can be
improved. From the junction of the Nolichucky River to the
ssee State line, 31 miles, the French Broad is not susceptible of
vement except by slack-water navigation, the fall being 7 feet
ile.

present project of improving the channel from mouth of river to
ale, about 90 miles, consists in removing surface obstructions,
g down overhanging trees, and building wing dams where neces-
o as to permit the passage of boats drawing 2½ feet during the
ry low-water season. Under this plan operations have been
l on at the most serious obstructions.

The following appropriations have been made by Congress for improving French Broad River in Tennessee, viz:

Act of—		Act of—	
June 14, 1880	$10,000	August 11, 1888	$10,000
March 3, 1881	3,500	September 19, 1890	10,000
August 2, 1882	5,000	July 13, 1892	15,000
July 5, 1884	3,500		
August 5, 1886	6,000	Total	63,000

The total amount expended to the close of the fiscal year ending June 30, 1893, including outstanding indebtedness, was $52,523.48. This expenditure has resulted in the improvement of ten of the principal obstructions below Dandridge by deepening and clearing the channel, removing fish-traps, constructing and modifying wing dams, and revetting the banks where necessary. A list of these ten obstructions, with their distances below Dandridge and the work done at each to June 30, 1890, is given in the Annual Report of the Chief of Engineers, 1891, pp. 2262, 2263.

The improvements made at Seven Island Shoals during 1889 and 1890 are therein reported as the most important effected on the French Broad River in several years, and have resulted in making this obstruction navigable for steamers at stages of the river when upstream navigation was heretofore impracticable. The work at these shoals, although not completed, has done much good. Before any work was done here by the United States it usually took a steamboat from one to one and a half days to go through, but now the passage can be made in forty-five minutes. At Bryant Shoal the modification and enlargement of the old wing dam and the removal of bowlders from the channel has greatly improved navigation. Great benefit has resulted from the improvement made at Jumping Moses Shoal, near mouth of the river, its dangerous condition having been greatly modified.

During the fiscal years 1891 and 1892, the improvements were continued at Bryant Shoals and Hanging Rock Shoals. The bar at the foot of Bryant Shoals was excavated and two dams constructed, running out from the north bank. The old dam, extending from the foot of McCroskey Island, was straightened and made parallel to the main current, then lengthened to hold water upon the shoal. Across the island chute, about 500 feet below the mouth of Pigeon River, a cut-off dam was built, submerging the bar complained of as shutting off all navigation during low water, through which the current will soon cut a good chute sufficient for the passage of boats. At Hanging Rock Shoals the channel was changed from the north to the south side of Brabson Island. The new channel was cleared of snags, drifts, etc., and some rock excavated. Eight dams were built, a retaining dam at foot of island with two spurs jutting toward the new channel to divide the fall and guard against the formation of a bar near the foot of the main dam; the old dam on the south bank of the island was utilized and 185 feet added to it in the direction of the new channel; two dams were built out from the south shore of Brabson Island, and two dams across the head of the chute, closing the old channel, which was left open as long as possible, and no detention of boats resulted from the change.

A small light-draft steamer, *Stephen H. Long*, was built at Chattanooga, Tenn., for use upon the Upper Tennessee and its tributaries, and was paid for from the proceeds of the sale of the U. S. S. *McPherson*, to the works on the Lower Tennessee River.

Work was in progress at the Hanging Rock Shoals at the beginning

resent fiscal year and was continued at several obstructions anuary 1, 1894, when operations were suspended, the funds le for channel work being nearly exhausted. The fleet with ngineer property was dropped down to winter moorings at Chat-, Tenn., as a measure of economy and safety.

k was carried on during the fiscal year at Hanging Rock Shoals, Shoals, Nichols Reef, and Zimmerman Ford, as follows:—

tripped	cubic yards	989
arried	do	5,075
s repaired and extended	do	1,803
ams built	do	1,390
otection, riprap	do	425
l from channel:		
l rock	do	377
e rock	do	30
s	Number	8
ging trees	do	65

nel excavated at Nichols Reef. Built check-dam and 180 feet dam; repaired and extended old riprap dams, and revetted Hanging Rock Shoals. Built riprap dam at Denton Shoals. 580 feet of old dams just below Zimmerman Ford; built out a ar dam from right bank, 108 feet long, just below the old dam. inations and maps were made of the obstructions at Evans Saffels Shoals, Hanging Rock Shoals, Cement Shoals, Camp-noals, and Pennyroyal Shoals.

work done during the past season appears to give satisfaction steamboat men, for, under date of June 21, 1894, Mr. D. M. Rose, nt and general manager of the Three Rivers Packet Company, e between Knoxville and Chattanooga on the Tennessee River tween Knoxville and Dandridge on the French Broad River, hat—

ver (French Broad) at this time is at its lowest and the boats are having a e of it; in fact, they can hardly get up as far as Pigeon River. The Bowman st below Riverdale, is the worst shoal. Pennyroyal and the Huffaker shoal to get over. We have no trouble at Hanging Rock or Wesley, and they say Rock is improving all the time and gets easier to get over. There seems to water in the Wesley Chute than ever before; it is cutting out and no trouble all.

mprovement of the French Broad River, Tennessee, is of vital nce to the inhabitants along its banks, not only by reason of easing commerce, but because of its being constantly used as a y for travel by the people themselves, a large number of pas-being carried by the small steamers that ply upon this stream. mmerce consists principally of marble, sand, logs, lumber, grain, live stock, wood, and general merchandise. The comple-the existing project of improvement will materially aid in the ment of the mines and will open a river highway for the trans-n of the mineral wealth of the mountains and the products of agricultural lands of the region drained by the river and its ries.

mount expended during the fiscal year, including outstanding dness, was $11,000.38.

balance ($88,000) of the original estimate of $150,000 for ing the French Broad River from its mouth to Leadvale is mani-nsufficient to secure the 2-foot ordinary low-water navigation to be obtained under the project. The examinations heretofore f the French Broad River were limited and incomplete, and are icient whereon to base a revision of the estimate of 1871. It a

radical improvement of the channel is to be undertaken, it is recommended that a detailed survey be made to obtain the data necessary to determine the cost of the work as projected, having in view its advantageous and economical prosecution.

LITTLE PIGEON RIVER, TENNESSEE.

This stream is formed by the junction of its east and south forks at Sevierville, Tenn., and flowing northwesterly for about 5 miles it enters the French Broad River about 32 miles above Knoxville.

An examination of Little Pigeon River was made under the provisions of river and harbor act of September 19, 1890. The channel was found to be obstructed by rock reefs and gravel shoals. The object of the proposed improvement at the estimate of cost submitted ($10,000) being to open up the river to navigation as far as Catlettsburg, about 2 miles, permitting the passage of the small steamers that ply upon the French Broad River, and occasionally during extreme high water to ascend to Sevierville, 5 miles from the mouth of river. (See Report printed as House Ex. Doc. No. 159, Fifty-first Congress, second session, and Report of Chief of Engineers, 1891, pp. 2287–2288.)

The river and harbor act of July 13, 1892, provided that of the $15,000 appropriated for improving French Broad River, Tennessee, $1,000 "may be used in removing bar or shoal in Little Pigeon River." This sum has been allotted for the removal of the bar near the mouth of the river, described as the only bad shoal below Catlettsburg. No work was done nor expenditures made during the fiscal year ending June 30, 1893.

A working party was organized in October, and operations were begun and carried on for twenty days in connection with those in progress upon the French Broad River. To overcome the obstruction or shoal near the mouth of the river, it was found desirable to excavate the channel at Gass Reef, and to use the excavated material and loose rock in building riprap dam. The dam in the large slough just above the mouth was repaired, and three small dams were also built across the small slough on the left bank to hold up the water in mouth of river. The following was the work done:

At Gass Reef:		
Solid rock removed	cubic yards..	70
Loose rock removed	do....	20
Quarry stripped	do....	135
Stone quarried	do....	416
Dam built	do....	506
Overhanging trees cut down	number..	60
Dams built, repaired, and extended across slough near mouth of river, cubic yards		431

The amount expended during the fiscal year was $633.10.

The balance of the estimate for this proposed improvement ($9,000) can be profitably expended during the next two fiscal years in the prosecution of channel work below Catlettsburg, as projected.

Estimate of cost of improving French Broad River, Tennessee, from mouth to Leadvale	$150,000.00
Amount appropriated	62,000.00
Amount allotted for Little Pigeon River, act of July 13, 1892	1,000.00
Amount received: Sale of steamer *McPherson*	900.00
Amount expended, including outstanding indebtedness, French Broad River	62,670.30
Amount expended, including outstanding indebtedness, Little Pigeon River	633.10

Money statements.

LITTLE PIGEON RIVER.

July 1, 1893, balance unexpended	$1,000.00
June 30, 1894, amount expended during fiscal year	633.10
July 1, 1894, balance unexpended	366.90
Amount (estimated) required for completion of existing project	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	9,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

FRENCH BROAD RIVER.

July 1, 1893, balance unexpended	$11,330.08
June 30, 1894, amount expended during fiscal year	10,968.75
July 1, 1894, balance unexpended	361.33
July 1, 1894, outstanding liabilities	31.63
July 1, 1894, balance available	329.70
Amount (estimated) required for completion of existing project	88,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

French Broad River, Tennessee, from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Grain	8,600	Cattle	180
Lumber	2,000	Wood	150
Flour	300	Horses and mules	100
Hogs	300	Bricks	80
Coal	200	Salt	75
Shingles	200	Tobacco	40
Hay	200	General merchandise	5,000

B B 5.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 104 miles above Chattanooga and 79 miles below Knoxville; the length of its course in Tennessee being about 230 miles.

Between 1830 and 1845, work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river, about 1,436 square miles, is mountainous and has very meager transportation facilities.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. Osborns Ford, Virginia, about 35 miles northeast of the Tennessee line, is regarded as the head of high-water navigation on the Clinch River. It has no low-water navigation. (See Report of Chief of Engineers, 1865, pp. 736–747.) An examination of the Clinch River from Nash Ford, Vir-

ginia, to Haynes or Walkers Ferry, Tennessee, a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1864–1867.) The original project, submitted in 1876, provided only "to improve the high-water navigation of this river, so that there shall be less difficulty and danger in bringing out cargoes, and so that rain tides of 3 or 4 feet may be made use of for boating purposes." This was estimated at $26,400. In 1881, the engineer officer in charge reports that he hoped to attain a permanent increase of depth of water in channel, by blasting rock, etc., "securing for about 145 miles of the lower river at ordinary low water from its mouth to Clinton, about 2 feet, and from Clinton to Walkers Ferry (Haynes) about 1½ feet," adopting the low-water channel, which in 1876 had been simply suggested as a channel that might be found practicable after a careful survey, and thus modifying the then existing project, but without increasing the original estimate which was simply for high-water navigation, by the cost of the channel projected. In 1885, the estimate was increased to $50,000, "because it had been found necessary to make the channel from two to three times the width thought sufficient when the original estimates were made," but the estimate was not increased although the proposed low-water navigation, instead of the high-water navigation, was adopted as part of the present project; therefore, the balance of the original estimate as modified and remaining unappropriated, $11,000, is manifestly inadequate to complete the work as projected.

The examinations made of the Clinch River are not sufficient whereon to base an estimate of the cost of the projected low-water channel below Walkers Ferry, but if radical improvement is to be undertaken it is recommended that a detailed survey be made to obtain the data necessary to determine the cost, having in view an advantageous and economical prosecution of the work.

Above Walkers Ferry to the Tennessee State line, about 85 miles, the only projected improvement is to reduce the ledges and remove loose rock, etc., sufficiently to assist flatboat navigation and rafting during "rain tides."

The following appropriations have been made for this improvement:

Act of—		Act of—	
June 14, 1880	$10,000	August 11, 1888	$5,000
March 3, 1881	3,000	September 19, 1890	4,000
August 2, 1882	3,000	July 13, 1892	4,000
July 5, 1884	5,000		
August 5, 1886	5,000	Total	39,000

The total amount expended to June 30, 1893, including outstanding indebtedness, was $35,806.26; the general results attained by this expenditure are that the reefs have been reduced, many snags and overhanging trees removed, and several strong, heavy wing and longitudinal dams built, thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun.

Above Haynes or Walkers Ferry special advantages were secured about ten years ago at Hunters Shoals, Sycamore Shoals, Hopson Shoals and Straight Shoals.

Below Walkers Ferry (Haynes) important work has been done at Black Shoals and Bletcher Shoals; at Cloud Shoals seven dams have been built and a heavy dam at Hibb Shoals, which, with the rock excavation in channel, have lessened the dangers to navigation. At Llewellyn Shoals, the improvements completed consist of reducing projecting rocky points, removing snags, sand, and gravel from the channel, completing wing dams, and constructing dam 190 feet long,

bout 324 feet below Moores Ferry or Ford. Safe navigation at these hoals is now reported possible at a stage of water from 1 to 1½ feet ower than before the work done in 1892 was begun. At Young Island he fish-trap dam was taken from the chute south of the island, but nore work is necessary to confine the water to one channel for the loating of logs to the mills below the island.

In July, 1892, partial examinations were made below the mouth of owell River, and in October below the mouth of Emory River, having n view the ascertaining, in a general way, of what work is necessary o be done to improve the channel to the extent of securing a navigable epth of 2 feet at ordinary low water.

No channel work was practicable during the fiscal year until Novemer, 1893; a little work was then done near Givens Ford, about one-alf mile below mouth of Emory River; 60 cubic yards of loose rock ere removed from channel and placed in riprap dams at this point; old weather and high water setting in, all work was necessarily susended until next season. The boats, with other engineer property peraining to the work, were dropped down to Chattanooga on the Tenessee River for moorings and placed with other property as a means f economy and safety.

The amount expended during the fiscal year, including outstanding ndebtedness, was $933.12.

Having reference to navigation and commerce upon the Lower Clinch River, the last Annual Report states that—

> The section of the river below Clinton, a distance of about 70 miles, is practicable or steamboat navigation during the higher stages of the river, and to increase the engtb of the season of navigation the present project contemplates the construction f wing dams and other channel work at the most troublesome obstructions. The rincipal navigation at present consists of logs and zinc ore. Immense tracts of ncut timber still remain in the country adjacent to this stream, and will for a long ime to come require its channel as a means of transportation. The product of the inc mines is brought down from time to time in flatboats to the reducing works at linton. These ore deposits are reported as being very extensive and practically lependent upon the river for transportation.
>
> The Loomis & Hart Manufacturing Company, of Chattanooga, Tenn., reports that bout 78 per cent of the logs reaching Chattanooga are run out of the Clinch and its ributaries, the Powell and Emory rivers.

Estimate for improving Clinch River, Tennessee, as modified in 1885	$50,000.00
Amount appropriated	39,000.00
Amount expended, including outstanding indebtedness	36,710.54

Money statement.

uly 1, 1893, balance unexpended	$3,222.58
une 30, 1894, amount expended during fiscal year	904.28
uly 1, 1894, balance unexpended	2,318.30
nly 1, 1894, outstanding liabilities	28.84
uly 1, 1894, balance available	2,289.46
Amount (estimated) required for completion of existing project	11,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	11,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Clinch River, Tennessee, from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Hay	237	Oil	9
Lumber	160	Iron	5
Grain	94	Bricks	1
Coal	80	General merchandise	12
Flour	10		

B B 6.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The Cumberland River rises in eastern Kentucky, on the western slope of the Cumberland Mountains; flows in a tortuous course of about 688 miles through eastern Kentucky, middle Tennessee, and western Kentucky, and discharges into the Ohio River near Smithland, Ky. From Point Burnside, Ky., the head of steamboat navigation, to Smithland, Ky., is 205 miles on an air line, while by the way of the Cumberland River the distance is 518 miles, 203 miles being in the State of Kentucky and 315 miles in the State of Tennessee.

From 1830 to 1840 the legislatures of Tennessee and Kentucky made several appropriations for the improvement of the navigation of the Cumberland River, but little benefit to the general condition of the river seems to have been accomplished. The Cumberland Navigation Company was incorporated by the State of Tennessee in 1846 for improving the "navigation of the Cumberland River below the town of Nashville by means of a system of locks and dams," but nothing tangible was done to carry out the proposed improvement.

Congress appropriated $155,000 for improving the river by acts of—

July 17, 1832	$30,000
June 28, 1834	30,000
July 7, 1836	20,000
March 3, 1837	55,000
July 7, 1838	20,000
Total	155,000

The amount was expended in carrying out the project authorized by act of Congress and based on the survey of Capt. Howard Stanbury.

From 1838 to 1871 no appropriations were made by Congress for improving the Cumberland River.

By act of July 11, 1870, Congress authorized an examination and survey of the Cumberland River. In Reports of the Chief of Engineers, 1871, pp. 468–485, and 1872, pp. 463–472, may be found the reports of Maj. Godfrey Weitzel, Corps of Engineers, U. S. Army, giving description of the Cumberland River from the Great Falls of the Cumberland to the mouth of the river at Smithland, Ky. This survey furnished the basis of the project under which the work below Nashville has been done, the original estimates having been increased in 1884 and 1888. From Nashville to Smith Shoals the work was carried on under the project of 1871 until 1887. A survey of the river from the head of Smith Shoals to Nashville was made in 1882 and 1883. (See Report of Chief of Engineers, 1884, pp. 1663–1675.) On this survey is based the present project of improvement by locks and dams of the

Cumberland River above Nashville. A survey of Smith Shoals made in 1874 (see Report of Chief of Engineers, 1875, pp. 795–800) is the basis of the project under which work was done at that obstruction from 1877–1883. A survey of the falls of the Cumberland River was made in 1878. (See Report of Chief of Engineers, 1879, pp. 1279–1282.) An examination above the falls was made in 1880. (See Report of the Chief of Engineers, 1881, pp. 1854–1859.)

Under provisions of act of August 11, 1888, a detailed instrumental survey was made of the "Lower Cumberland River from Nashville to its mouth to ascertain if necessary to establish locks and dams." (See Report of the Chief of Engineers, 1890, pp. 2151–2161.)

The sixteen appropriations made by Congress from 1871 to 1892 amount to $1,466,000, and are itemized under the heads of "below Nashville" and "above Nashville."

The obstructions are of a uniform character, consisting of rock ledges, gravel and sand bars, bowlders, snags, overhanging trees, and other surface obstructions. The Cumberland River supplies in many cases, both above and below Nashville, the only means of transit between the towns and villages lying along its course.

1. BELOW NASHVILLE (191 MILES).

The Cumberland River below Nashville is navigable for all steamboats plying on it for six months in each year; for boats not drawing over 3 feet, from six to eight months; and for boats drawing 16 inches or less, for the whole year.

Up to this time the work below Nashville has been carried on under the project of 1872, which, to quote from the original report, is—

> To excavate the bars and rock ledges to get an additional depth of water, to contract the waterways in places to get the requisite depth, to remove snags and bowlders from the main channel, and to restrain tributary streams in well determined channels at their junction with the river.

In seasons of unusually low water the mouth of the river near Smithland, Ky., is seriously obstructed by the formation of sand bars.

The following appropriations have been made for the section of the river below Nashville, under the old project and estimates:

Act of—		Act of—	
March 3, 1871	$30,000	August 2, 1882	$15,000
June 10, 1872	20,000	July 5, 1884	7,500
March 3, 1873	25,000	August 5, 1886	12,500
March 3, 1875	25,000	August 11, 1888	10,000
June 18, 1878	45,000	September 19, 1890	40,000
March 3, 1879	40,000		
June 14, 1880	20,000	Total	305,000
March 3, 1881	15,000		

The board of engineer officers (see Chief of Engineers' Report, 1888, pp. 1626–1632) recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600, so as to increase the depth of water at the shoals at the junction of the Cumberland River with the Ohio River. The river and harbor act approved September 19, 1890, provides that $30,000 of the appropriation for improving the Cumberland River below Nashville shall be expended in improving the mouth of the river, and the act of July 13, 1892, appropriated $40,000 for continuing the improvement, including the mouth of the river, and "that $10,000 of this sum, or so much thereof as may be necessary, shall be available for acquiring site and locating lock and dam near the mouth of Harpeth River, Tennessee, according to the survey and plan of Lieut.

Col. Barlow, Corps of Engineers, U. S. Army, submitted in December, 1889." (See Report of Chief of Engineers, 1890, pp. 2151–2161.)

This forms the initial movement for work under the plan above mentioned. The project now in force for improving this section of the river according to the plan submitted consists (1) of the extension of the lock and dam system of the Upper Cumberland to the lower river by the construction of 7 locks and dams, extending from near the mouth of Harpeth River (Lock A) to Big Eddy Shoals (Lock G), the lock chambers to be each of 280 feet available length by 52 feet width, the lifts of the locks varying from 8½ to 11½ feet, aggregating about 70 feet; (2) of the improvement of the Kentucky Chute at mouth of river, as recommended by board of engineer officers June 16, 1888, (Report of Chief of Engineers, 1888, p. 1628); (3) of the channel work necessary below Lock G, between Big Eddy Shoals and mouth of river; and (4) snagging and removal of surface obstructions below Nashville. Total estimate of cost of entire improvement under revised project, $1,964,500; which is given in this report as the amount (estimated) required for completion of existing project, less the amount appropriated for the work projected by—

Act of July 13, 1892..... $40,000

The amount expended to June 30, 1893, including outstanding indebtedness, and amount covered by contract, was $319,990.01, which expenditure has resulted in lengthening the season of navigation by giving an increased depth at low water, combined with the greater security in the passage of the worst obstructions; improvements more or less complete being effected in the general river at Harpeth Shoals, Palmyra Bar, Elk Creek Shoals, Dover Shoals, Big Eddy Shoals, etc. Rebuilt and refitted U. S. snag boat *Weitzel*, for snagging, etc., in Cumberland River, upon which work she was employed during part of the fiscal years 1892 and 1893.

Under contract the work of building dike and shore protection at mouth of river was nearly completed, and by hired labor the old dams were entirely removed to increase the width of channel; the shore of Cumberland Island, in the vicinity of the dams was protected by riprap, and the bank above foot of the island, opposite the Kentucky mainland for a length of about 3,150 feet was protected by driving piles near the low-water line and revetting the bank with rock and brush. This work is completed, and the bank now thought to be permanently protected from erosion.

The necessary surveys were made and sites selected and approved for proposed lock and dam (A) at or near the mouth of Harpeth River, as provided by act of July 13, 1892.

The work of dike construction at mouth of river, under contract of March 12, 1890, with Mr. Frederick Hartweg, of Cincinnati, Ohio, was finished in August, 2,000.27 cubic yards of stone, at 94 cents per cubic yard, and 255 cords of brush, at 79 cents per cord, being placed in position during the fiscal year; the contract was terminated August 26. In September, part of the old upper dam was removed by hired labor, to permit the passage of steamboats without danger.

No channel work was done during the fiscal year.

The sites for lock and dam (A), about 2½ miles below the mouth of Harpeth River, were condemned by the U. S. district court; payment has been made into court for the lock site, 12 acres, including costs, $1,009.60, and decree issued by said court vesting title to the same in the United States; the title to the site of abutment of dam, 3.9 acres,

aving been examined and approved June 26, payment will be made for ıe site, including costs, $369.34, and title vested in the United States ithout unnecessary delay. Therefore, as soon as the necessary funds re made available, the construction of lock and dam A can be begun nd prosecuted to completion, and the most formidable obstruction to he navigation of the Lower Cumberland—the Harpeth Shoals—thus e overcome.

The amount expended, including outstanding indebtedness, during he fiscal year was $9,699.06, divided as follows:

ieneral improvement	$734.61
.t mouth of river	5,796.06
ock and dam near mouth of Harpeth River	3,168.39
Total expended	9,699.06
The estimate of cost of improving Cumberland River below Nashville, in accordance with revised and existing project of 1889	1,964,500.00
mount appropriated, act of July 3, 1892	40,000.00
mount expended, including outstanding indebtedness	17,779.21

Money statement.

uly 1, 1893, balance unexpended	$31,919.85
une 30, 1894, amount expended during fiscal year	9,182.86
uly 1, 1894, balance unexpended	22,736.99
uly 1, 1894, outstanding liabilities	516.20
uly 1, 1894, balance available	22,220.79
Amount (estimated) required for completion of existing project	1,924,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

ABOVE NASHVILLE (497 MILES), FROM NASHVILLE TO CUMBERLAND FORD.

The Cumberland River is navigable from Nashville to Point Burnside, Kentucky, 327 miles, for steamboats drawing not more than 3 feet om four to six months of each year, and for boats of greater draft om two to three months.

From Nashville to mouth of Caney Fork River (Carthage, 116 miles), ıe river is navigable for steamboats of 2½ feet draft from six to eight onths, and for those of greater draft four or five months. Steamboats light draft can ascend to Burksville, 236 miles above Nashville, for om five to seven months, and larger boats four or five months.

The obstructions in the river above Nashville are of the same general haracter throughout, consisting of ledges, gravel and sand bars, owlders, snags, overhanging trees, and rapid currents, and of millams in the section of the river above the mouth of Jellico Creek.

About 50 miles above Burnside, Ky., are the Great Falls of the umberland, a vast barrier to navigation, the difference of level etween crest and foot of the main fall alone being about 54 feet. uith Shoals, 10 miles above Burnside, Ky., having a fall of 55 feet in ½ miles, form the most serious obstacle to navigation below the Great alls.

The appropriations made by Congress for improving the Cumberland River above Nashville, under the original projects, were divided by years and geographical divisions as follows:

Geographical division.	Acts of—							
	Aug. 14, 1876.	June 18, 1878.	Mar. 3, 1879.	June 14, 1880.	Mar. 3, 1881.	Aug. 2, 1882.	July 5, 1884.	Total.
1. Nashville to Kentucky line	$15,000	$20,000	$18,000	$15,000	$15,000	.....	.....	$83,000
2. Kentucky line to Smith Shoals	10,000	8,000	6,000	10,000	15,000	.....	.....	49,000
3. Smith Shoals	25,000	30,000	15,000	20,000	10,000	$15,000	.....	115,000
4. Smith Shoals to Falls of Cumberland	2,000	2,000	.....	.....	.....	.....	.....	4,000
5. Above mouth of Jellico, Ky	.....	.....	.....	.....	10,000	5,000	.....	15,000
6. Nashville to Smith Shoals	.....	.....	.....	.....	.....	30,000	.....	30,000
7. Nashville to head of Smith Shoals	.....	.....	.....	.....	.....	.....	$50,000	50,000
Total	52,000	60,000	39,000	45,000	50,000	50,000	50,000	346,000

These appropriations, aggregating the sum of $346,000, have been expended in the several sections as designated, excepting the sum of $5,000 originally appropriated by act of August 2, 1882, for the section "above the mouth of Jellico, Kentucky," but which was made available by act of September 19, 1890, for expenditure, and "to be applied to the removal of snags and sand bars in the said Cumberland River above Nashville, Tenn.," and which has been so expended.

The disbursements incident to the works above Nashville under the above-named appropriations were from March, 1877, to December, 1887, and the work done consisted of clearing the channel of snags and other surface obstructions, in deepening the channel over the worst shoals by excavation, and the construction of wing dams, and has resulted in obtaining an increased depth at several of the principal obstructions, and thus securing each year a longer and safer period of navigation.

The instrumental surveys of 1882 and 1883 (see Report of Chief of Engineers, 1884, p. 1663, *et seq.*) furnish the basis of the present project for the radical improvement of the Cumberland River.

FROM NASHVILLE TO THE HEAD OF SMITH SHOALS.

This project provides for the construction of twenty-three locks and dams between Nashville and Burnside, Ky., and of seven locks and two dams at Smith Shoals, using the river itself as a canal, one dam at Mill Shoals and the other at or near Shadowen Shoals, at an estimated cost of $4,077,922, increased in 1891 to $7,500,000,

The act of July 5, 1884, appropriated $50,000 and provided that the "improvement shall be made according to the recommendation of Maj. W. R. King, engineer in charge, contained in the letter of Secretary of War, March 15, 1884, Senate Ex. Doc. No. 129, first session Forty-eighth Congress."

It is provided in said executive document that the dimensions of the seven locks at Smith Shoals are to be "55 feet by 140 feet in the chamber," and the twenty-three locks between Nashville and Burnside, Ky., "should be about 60 feet wide and 250 feet between miter sills, though perhaps smaller dimensions would answer the purpose."

The act of August 5, 1886, specifically provided for this work of canalization "with a view to secure in the channel a depth of 4 feet,

mencing with the lock at or near the lower island at Nashville."
Board of Engineer Officers constituted to examine and report upon plan and estimate for this lock (No. 1) recommended a lock of the owing dimensions: 280 feet long, 52 feet wide, from 10 to 12 feet lift, h 4 feet of water on lower and 5 feet on upper miter sill. This ommendation was approved by the Chief of Engineers and the Secary of War. (See Report of Chief of Engineers, 1888, p. 1622, *et seq.*)
he plans first submitted provided for a lock (No. 1), fixed dam, and tment of such dam, but upon further consideration by a Board of gineers it was recommended conditionally and approved that a movadam be constructed instead of a fixed dam. (See Report Chief of gineers, 1890, p. 2143, *et seq.*) This Board, in a subsequent report dated ember 26, 1890 (6793, 1890), for reasons therein given, withdrew its ner suggestion and recommended the construction of a fixed dam as ginally proposed.
he Board of Engineers constituted to examine and report upon the n and general design of Lock 2 recommended in their report, November 25, 1890 (6727, 1890), a lock of 280 feet available length, 52 feet erior width, conforming to the dimensions prescribed for Lock 1, but ommending a depth of 6½ feet of water on the upper miter sill, and s to provide for a minimum navigation of 6 feet instead of 4 feet, ause "this can be done without extra cost," and is "necessary for economical transportation of coal."
he plan for Lock 2, as approved, shows a uniform depth of 6½ feet water on the sills.
he style of dam being thus determined, new plans for Lock No. 1, viding for a depth of water of 4 feet on the lower and 6½ feet on the er miter sill and for a fixed dam and abutment, were submitted to Chief of Engineers and by him referred to the Board of Engineer cers, who, in their report of April 20, 1891, recommended the plans approval, the report of the Board being approved by the Secretary r April 25, 1891. the plan for Lock No. 1 submitted being of "almost ntical with the * * * plans for Lock No. 2" (see Report of Chief Engineers, 1891, p. 2280, *et seq*), Lock No. 1 having a lift of 9 feet and Lock No. 2 a lift of 11 feet.
ocks of larger dimensions have been adopted for the section from shville, to Burnside, Ky. As a modification of the existing project, ecame necessary to revise the estimates submitted in 1882 and 1883, l such revision was made in the Annual Report of the Chief of Engirs, 1891, p. 2270, as follows:

lans and estimates for locks Nos. 1 and 2 have been prepared and contracts for tions of the work have been made, from which it is now estimated that each lock dam will cost not less than $250,000. An estimate of the section from Nashville Point Burnside, provided twenty-three locks be found necessary, amounts to 50,000, and to continue the improvement to the head of Smith Shoals, with seven itional locks and dams of equal cost, would amount to $1,750,000 more, or a total 7,500,000, an increase of the original estimate by $3,422,078, which modification ade and submitted in this report. By increasing the lift of the locks it may be id possible to decrease their number, and thus complete the improvement at a ced cost.

he appropriations made for work under the present project from shville to the head of Smith Shoals are as follows:

of—

August 5, 1886	$75,000
August 11, 1888	200,000
September 19, 1890	250,000
July 13, 1892	250,000
Total	775,000

In 1892 the engineer officer then in charge, having under consideration the object of improvement, the provisions of the several acts of Congress relating thereto, and the needs of the work bearing upon its rate of progress and time of completion, together with the contingencies developed since its commencement, reported that—

The Board of Engineers of 1887, in its report on this improvement, says: "The locks on the Cumberland River are assumed to be specially intended for the development of the coal traffic on the Upper Cumberland." While one member dissented from the recommendation of the Board as to the size of the locks, thinking smaller ones preferable, in giving his reasons for his opinion he also assumes that the requirements of the coal trade should settle the question. He says: "While uniformity is a desirable thing in such matters, I do not think it would be just to those most interested in the development of the coal trade on the Cumberland River to build larger locks than they desire, especially as it would delay and increase the cost of the work."

The act of Congress of September 19, 1890, provided for the expenditure of $50,000 at Smith Shoals, subject to the approval of the Secretary of War. The great coal region on the Cumberland is above these shoals, and it is estimated that the construction of some seven locks at these shoals would connect that region with the Cumberland at Burnside, just at the crossing of the Cincinnati Southern Railroad. Below this point the Cumberland is navigable for at least four months of the year. The building of these seven locks will certainly tend to the development of the coal trade as much as the construction of the same number of locks just above Nashville, and therefore, in view of the language of the last appropriation act, I recommended that the $50,000 be expended as indicated in the act. This recommendation was approved, and a careful survey of the river from the first shoal below Burnside to the head of Smith Shoals will be made, as well as observations made to determine the volume and velocity of the current at the various stages of the river and examinations for lock sites, etc. It is proposed when lock sites have been definitely determined to take proper steps for securing the necessary land.

A lock and dam constitute an obstruction to navigation which is only justifiable when their aid to navigation more than counterbalances their injury. The locks alone are no obstruction. The dams should not be built until they are required as an aid to navigation, which will not be until after more than a half dozen locks are built. By this plan the river will be unobstructed with dams until their construction will be an immediate benefit, and for these years the improvement is saved the expense of maintaining lock-keepers and the wear and tear on lock machinery and the dams. It is proposed to prosecute work simultaneously on as many locks as the available funds will permit.

If an appropriation of $500,000 was made for this improvement every other year for the next twenty-eight years its completion could be expected in a little more than thirty years from now. During this thirty years, if nothing is done for the river except the building of the locks and dams, navigation, instead of being improved, will, for most of the time, be worse than it is to-day. The permanent improvement of the river by locks and dams will benefit the next generation, but in the meanwhile the present generation should not be overlooked. In my opinion not less than $5,000 a year—and special circumstances may require a larger amount some years—should be expended on this part of the Cumberland River, over 300 miles in length, in building and repairing temporary dams, in snagging, and other necessary work. I do not estimate for this separately, as it is so small compared with the amount that should be appropriated for the improvement.

As Congress has indicated by its designating $50,000 for starting the work at Smith Shoals that it desires the work to be carried on there as well as at the locks immediately above Nashville, provided there are no serious engineering objections, it is proposed in the future to prosecute the work from both points at as many locks as the funds available will permit. It would seem better to treat all the locks as one improvement, and not to limit a part of the appropriation. It is possible that complications about obtaining a suitable site, or other causes, might leave one portion of the river with more funds than were necessary, while the other part was suffering for the lack of money on account of the appropriation being divided.

The amount expended to the close of fiscal year ending June 30, 1893, including outstanding indebtedness but not including the amount pledged by existing contracts, was $260,877.59, of which $5,773.44 was expended at Smith Shoals. This expenditure has been applied in the examinations for sites of locks and abutment of dams Nos. 1, 2, 3, and 4 (old site of Lock 2); in purchase of lock sites 1 and 2 (old site No. 2)

nd abutment of Dam No. 3; construction of lockkeeper's house, No. , and laying masonry of lock and abutment of Dam No. 1; in build- ng cofferdam at old site of Lock 2, and payments in settlement of con- ract discontinued and terminated for building Lock 2; in purchase f dredge and building new hull for same and transferring the dredge achinery; the lumber and iron for cofferdams, temporary buildings, nd barges, vitrified brick for lock foundation and culverts; rails for ramways, hoisting and pumping machinery, were purchased and moved ith other plant to the lock sites in readiness for active operations s soon as the title to the sites for locks 3 and 4 was vested in the nited States; in necessary channel work below Burksville; clearing urface obstructions, reducing rock ledges and gravel bars; repairing nd building riprap dams at several points. At Smith Shoals, organiz- ng a party for the survey of Smith Shoals, or, more definitely, of the river rom Burnside to mouth of Rockcastle River, under the allotment pro- ided by acts of September 19, 1890, and July 13, 1892; made observations o determine river discharge at different stages, and gauge readings at ix stations; made detailed surveys for the proposed sites of the first wo locks of the Smith Shoals system of lockage.

Only one contract was in force during the present fiscal year, that f Henry F. Holmes, dated October 17, 1890, for completion of the asonry of Lock 1, date of completion being extended to December 31, 1893. The prices per cubic yard in place for work under this contract eing for backing, $8.50; rock face, $11; pointed face, $12; quoins, $30; coping, fine pointed, $16. Contract completed and closed November 17, 1893.

Total amount expended under the contract, $46,388.65.

Under date of March 25, 1893, my predecessor in charge, Lieut. Col. Henry M. Robert, Corps of Engineers, reported to the Chief of Engi- neers, that—

> After a somewhat careful investigation of the subject, I am satisfied that the work can be done by hired labor and purchase in open market as cheaply as by contract, besides accomplishing the work in one or two years less time on each lock.
>
> * * * * * * *
>
> It would be advisable, therefore, to have authority to do the entire work by hired labor and purchase of materials in open market; provided, however, that the dimension stone, in whole or in part, may be contracted for, if deemed hereafter advisable by the engineer officer in charge.

The authority sought, as above stated, was granted March 28, 1893. Under its provisions advertisements were issued June 20, 1893, invit- ing proposals for supplying 7,912 cubic yards cut stone, as classified in specifications, for building locks Nos. 3 and 4, Cumberland River. The bids, two in number only, were opened July 11, 1893. The prices in each bid being deemed excessive, it was recommended that the bids be rejected and the stone procured in open market, as the method most economical and advantageous to the Government and the work. This was approved, and a part of the stone for Lock No. 3 is now supplied by Messrs. Foster & Creighton, of Nashville, delivered on barges at Edgefield Junction, about 3 or 4 miles from Lock No. 3, thus saving the cost of water transportation for the 22 or 23 miles between Edgefield Junction and Nashville, the latter place being the point selected for delivery on the lower of the bids offered.

The approximate quantity of stone bought in open market of Foster & Creighton, for and in behalf of the United States, aggregates 8,637 cubic yards, classified as sills, hollow quoins, pointed face, square-faced rubble, special stones, and backing. About one-third of this stone has

been delivered during the fiscal year and the remainder will be delivered in due season.

A change was recommended in February, 1894, approved by the Chief of Engineers March 1, 1894, in the classification of the stone upon which the bids were made in July, 1893, due to a change of the character of the masonry of the outer face of the river wall, thus changing the classification of some of the dressed stone, substituting rubble for rock face. In all respects the strict requirements of the specifications are as fully and rigidly enforced in the examination of the stone prior to acceptance, as if the stone were supplied under a formal written contract.

During the fiscal year the purchases have been made and the entire work prosecuted under the hired-labor and open-market system, excepting the 3,449.58 cubic yards of masonry laid to complete the walls of Lock No. 1, under the contract above mentioned.

Lock No. 1.

Under contract:		
Pointed Face	cubic yards..	782.26
Rock Face	do....	480.65
Quoins	do....	38.29
Coping	do....	392.26
Backing	do....	1,756.12
Total	do....	3,449.58
By hired labor:		
Stone filling placed behind land wall of lock	cubic yards..	3,600.00
Paving laid over filling	superficial yards..	972.00
Stone placed as retaining wall above and below abutment	cubic yards.	2,595.00

Began work on survey of lock site and its approaches and topographical map of the same; established a base line for locating soundings, and made soundings in lower approach.

Lock 2.—At the old site the cofferdam had been built and excavation for the lock chamber begun under contract in 1891, but owing to the doubtful character of the site operations were discontinued, and contract terminated August 19, 1892. A thorough reexamination of the old site by a series of test borings and soundings was made, and similar surveys also completed at other locations below the present site which were deemed suitable for the construction of the lock. Report was submitted to the Chief of Engineers February 3, 1894, recommending that the old sites for lock and dam 2 be abandoned, and that new sites, about 1½ miles below the old sites, be approved. The new sites, 9 miles above Nashville, were approved March 1, 1894. The lands for the lock site and necessary right of way were purchased May 14, 1894, at a cost of $1,461.25. The site for the abutment of the dam has not yet been obtained; the question of a voluntary purchase is yet pending.

In April work was begun. Fifty cubic yards of loose rock, 7 snags, and 26 trees were removed in clearing site and right of way; dredged 8,000 cubic yards of sand and gravel to form trench for cofferdam foundation; moved timber, iron, etc., to lock site, and built 199 linear feet of cofferdam; temporary buildings erected, and an incline for moving stone begun.

Lock 3.—The site for lock, with necessary right of way, was acquired by condemnation proceedings in the U. S. district court. Three final decrees issued, one in May and two in July, 1893, vesting title in the United States. Payments were made into court for said lock site and right of way, including costs, $2,308.85. The site for abutment of dam was

obtained by voluntary purchase, May 24, 1893, for $208.50. As soon as title to the lands became vested in the United States active operations were begun. United States lands were fenced; quarry opened; graded track for incline from top of bank to river; temporary buildings for quarters and storage erected; built cofferdam, landing pier, and trestle for steam traveler; excavated from lock site about 5,575 cubic yards of rock, earth, and gravel, and placed same in cofferdam; removed 17,063 cubic yards of earth, 1,100 cubic yards of gravel, and 2,047 cubic yards of solid rock from lock pit, nearly completing the lock-chamber excavation. Laid 22,400 bricks in the foundation of about eight-tenths of the river wall and one-half of the filling culverts; also laid about 30 cubic yards of concrete. Erected two derricks in lock pit, and fitted up steam traveler for moving stone. About one-third of the stone for masonry of lock purchased and stored under traveler ready for placing in lock walls.

Lock 4.—The sites for lock and dam, with necessary right of way, were acquired by condemnation proceedings in the U. S. district court. Three final decrees, two in January and one in May, 1893, were issued vesting title in the United States. Payments made into court for said lock site, including right of way and costs, $1,872.15, and for abutment site, $529.41. As soon as the title to the lands was vested in the United States active operations were begun. Lock site was fenced; road opened through right of way to the Gallatin pike; graded right of way from lock site to county road; erected temporary buildings at quarries and lock site; quarries opened to supply filling for cofferdam and dimension stone for masonry; cofferdam and landing pier built. Constructed trestle 380 feet long for moving steam traveler; tramways 2,500 feet long, from quarry to river, with trestle 230 feet long for tram track. Earth excavated from lock site and placed in cofferdam, 6,111 cubic yards; excavated from lock chamber and placed in cofferdam, solid rock, 1,532 cubic yards, and earth, 9,326 cubic yards. About nine-tenths of the lock chamber and land wall excavation, and one-half of the brickwork for the filling culverts, and all the brickwork and concrete for the foundation of river wall are completed; 280 cubic yards of concrete and 108,000 bricks were laid in foundation, 43,000 in the river wall, and 65,000 in the filling culverts. Two derricks were erected in lock chamber and one on cofferdam for unloading stone from barges; five new derricks were framed and six old ones rebuilt for use at quarries and stone yards.

For the masonry of lock: Stone quarried, 4,520 cubic yards; backing, 1,699 cubic yards. Stone cut: Pointed face, 989.85 cubic yards; rock face, 292.54 cubic yards; hollow quoins, 70.38 cubic yards. On the river wall 351.6 cubic yards of masonry were laid. All the stone cutting, with other work on this lock, is done by hired labor.

Lock 5.—Made extended examinations during the early part of the fiscal year at various points in order to secure a proper location for the lock, considerable difficulty being found on account of bad foundations. The proposed sites for lock and dam, with right of way, were approved February 7, 1894, and purchase authorized March 3, 1894. The lock site contains 8.8 acres, of which 7.3 acres, with necessary right of way, have been paid for and deed executed conveying same to the United States; amount paid, $900. The remaining 1.5 acres have not yet been conveyed to the United States by reason of a defect in the chain of title. As soon as the title is perfected, payment of the price agreed upon and approved ($125) will be made and deed executed conveying same to the United States.

The site for abutment of dam, which includes the low water sand bar known as Chambers Island, has been purchased and paid for and deed executed conveying same to the United States; amount paid, $510 As soon as the title was vested in the United States, May 22, 1894, active operations were begun. Materials for construction of cofferdam and temporary buildings were moved to the lock site. The temporary buildings for quarters and storage have been built, and the crib-work foundation of cofferdam for average height of 5 feet has been constructed from bank to bank and two-thirds filled, about 1,164 cubic yards of gravel and sand being used for that purpose.

Lock 6.—Extended examinations, with test borings and soundings, were begun early in the fiscal year to find suitable sites for the lock and dam. Sites were selected about 2½ miles above Hartsville Landing, and submitted February 15 and approved February 28, 1894. Negotiations are progressing having in view the acquiring of the lands by voluntary purchase from the owners.

Lock 7.—The examination necessary to determine and select suitable sites for the lock and dam was begun in May and was progressing at the close of the fiscal year.

The lands already acquired by the United States for sites of locks and dams, under the existing project, with distances from Nashville, acreage, and cost, are as follows:

No. 1: 2½ miles below Nashville, 7.8 acres; cost, $1,360.
No. 2, old site: 10¼ miles above Nashville, 12½ acres; cost, $750.43.
No. 2, new site: 9 miles above Nashville, 12.05 acres; cost, $1,461.25; abutment site not yet acquired.
No. 3: 26 miles above Nashville, 15.2 acres; cost, $2,517.35.
No. 4: 44¾ miles above Nashville, 14.8 acres; cost, $2,401.56.
No. 5: 72 miles above Nashville, 18.5 acres; cost, $1,410; 1.5 acres of lock site not yet acquired.
No. 6: 89½ miles above Nashville, 12.85 acres; not yet acquired.

U. S. S. Weitzel.—During the fiscal year the work of transforming this steamer into a towboat suitable for the heavy towage incident to the work of lock construction was perfected, as authorized, at a cost of about $4,453. The steamer has been refitted with powerful machinery, consisting of two new 12 by 48 inch engines, with boiler, new wheel, and a general strengthening and repairing of deck, etc. On comparison with the work done by her last year, this steamer has proved very successful in moving heavy supplies and towing stone, etc., to the works. In fact, the service rendered by the *Weitzel* last spring was such as could not have been given by any other steamboat on the Cumberland River.

U. S. S. John Phoenix.—Authority was obtained in June, 1893, to construct by hired labor a small steamboat of light draft for use in survey for lock sites and in the general work of improvement and assisting in the maintenance of the improved channel. A boat, 65 feet long, 13 feet wide, and 2½ feet deep, was built in August last at a cost of about $2,200, as authorized, and is rendering efficient service.

The U. S. S. *Stephen H. Long*, pertaining to the works of improvement upon the Tennessee River and during the suspension of work upon that river and its upper tributaries, was transferred temporarily by authority for use upon the Cumberland River as a measure of economy and to prevent deterioration in value from non-usage.

Six large-decked stone barges, each 110 feet by 22 feet by 5 feet, were built for moving stone from quarries and stone yards to lock sites, at an aggregate cost of $5,790.

Channel work.—In August an examination of the river from Burn-

side, Ky., to Holleman Island Shoals, a distance of 183 miles, was made during the month, to ascertain the condition of the channel, especially in reference to surface obstructions and condition of buoys marking the dams at high water; also to make survey of Wild Goose Shoals, Kettle Creek Shoals, and lower Hollemans Island, having in view the preparation of plan for the reducing of these obstructions.

Wild Goose Shoals.—In September the much needed modification of the dams at this obstruction was carried out. The old main dam was cut down to below low-water mark for a distance of 450 feet, and a check dam 241 feet long, 50 feet wide at base and 16 feet on top, was built to force the current down the island or channel side. The channel was thoroughly cleared; 1,144 cubic yards of loose rock were taken from dam, 440 cubic yards of stone and gravel were removed from channel, 726 cubic yards of stone placed in check dam, and 418 cubic yards as riprap on bank of island.

Kettle Creek Shoals.—In October a dam 116 feet long, 16 feet wide, and 4½ feet high, was built of rock excavated from the channel; 28 overhanging trees cut down. Work at shoals completed October 25; the working force then dropped downstream to Gallatin, Tenn., clearing the channel of surface obstructions; 45 snags were removed from channel and island chute at Cub Creek, Tackets Island, Upper and Lower Holleman Islands; 325 overhanging trees were cut down between Kettle Creek and Hollemans Island; the dam at Cub Creek was also repaired. In November cleared channel of 24 snags and 193 overhanging trees, and removed 75 cubic yards of rock at eight localities between Snow Creek and Bledsoes Towhead; dam repaired at Sand Shoals. Work was suspended by high water about the middle of November. Work was resumed in June, clearing the channel of surface obstructions from the foot of Hollemans Island to Carthage, Tenn., about 24 miles; about 500 snags and 142 overhanging trees were removed at various points in this reach of river; 16 cubic yards of rock were excavated at Sand Shoals (4) and West Point (12). Work was progressing near Carthage at close of the fiscal year.

The total amount expended during the fiscal year, excepting the expenditures at Smith Shoals, was $209,140.46, approximately divided as follows:

Lock No. 1	$44,587.60	Steamer *Weitzel*	$9,526.30
Lock No. 2	11,113.05	Steamer *John Phoenix*	3,382.10
Lock No. 3	41,912.49	Steamer *Stephen H. Long*	455.62
Lock No. 4	71,937.40	Boats and barges	6,456.94
Lock No. 5	9,834.37	General expenses	6,103.78
Lock No. 6	448.84		
Lock No. 7	811.59	Total	209,140.46
Channel work	2,570.38		

Smith Shoals.—By act of September 19, 1890, Congress provided that of the general appropriation for improving Cumberland River above Nashville, $50,000 may be expended in commencing the improvement at Smith Shoals, and by act of July 13, 1892, provided that $5,000 of a like general appropriation may be used "in the improvement of the river above the town of Burnside." It was recommended and approved that these sums be applied in making the necessary surveys to determine the sites of the locks and dams required "above Burnside," or for the Smith Shoals system of lockage consisting of seven locks and two dams, as projected.

The maps on hand not containing data sufficient in detail for the purpose of selecting the sites of any of the locks, a survey party was organized, and on July 25, 1892, an examination was begun of the river from Burnside to the mouth of Rockcastle River, and the results have all

been platted on a suitable scale. Observations to determine the discharge of the river at different stages have been made. Gauge readings were taken daily during the winter and spring at six different stations. Examinations in detail have been in part completed for the proposed sites of the first two locks in the series.

The amount expended during the fiscal year ending June 30, 1893, was $5,773.44, with the results as above stated.

During the fiscal year the examination for sites of locks and dams, Nos. 1 to 5 inclusive, of the Smith Shoals system have been made and maps completed showing location of proposed sites. A large number of test borings were necessarily made in order to determine the most suitable sites. The site for Lock 6 has not yet been selected, but will be soon determined, survey for site being resumed in July.

Seven locks and dams providing for 6-foot navigation form the basis of the project, but it is now ascertained that the seventh lock will not be necessary, owing to an increase of lift in the other locks; the proposed modification of existing project will be submitted with maps of the proposed sites for approval as soon as practicable. The amount expended during the fiscal year at Smith Shoals was $5,242.23.

The act of July 13, 1892, provides for an expenditure from the appropriation of $250,000 for improving Cumberland River above Nashville; of "$5,000, in the discretion of the Secretary of War, in the improvement of the river above the town of Burnside." The project for its expenditure, as approved, provides that it "be applied to continuing the work projected immediately above Burnside at Smith Shoals."

Amount allotted at Smith Shoals, act of September 19, 1890	$50,000.00
Amount allotted "above Burnside," act of July 13, 1892	5,000.00
Total allotted	55,000.00
Amount expended	11,015.67
Balance available July 1, 1894	43,984.33

The field and office work pertaining to the surveys of the sites for locks and dams, forming part of the project for canalization of the Cumberland River from the mouth of Harpeth River on the Lower Cumberland to the head of Smith Shoals—mouth of Rock Castle River—including the work of lock construction in progress at Locks Nos. 2, 3, 4, and 5, and the preparatory work necessary in the construction of Locks and Dams Nos. 6 and 7, has been and now is under the efficient immediate management of Mr. J. S. Walker, principal assistant engineer, having under his direction an overseer at each of the locks and an assistant engineer, Mr. Alfred Petry, at Smith Shoals, in local charge.

Estimate for improving Cumberland River by locks and dams from Nashville to head of Smith Shoals, as modified in 1891	$7,500,000.00
Amount appropriated	775,000.00
Amount expended, including outstanding indebtedness	500,715.85

Money statement.

July 1, 1893, balance unexpended	$539,433.86
June 30, 1894, amount expended during fiscal year	214,382.69
July 1, 1894, balance unexpended	325,051.17
July 1, 1894, outstanding liabilities	50,767.02
July 1, 1894, balance available	274,284.15
Amount (estimated) required for completion of existing project	6,725,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for furnishing cut stone for locks delivered on bank of Cumberland River, opened July 11, 1893, by Capt. John Biddle, Corps of Engineers.

WHOLE QUANTITY.

No.	Name and residence.	Sills, 186 cubic yards.		Hollow quoins, 196 cubic yards.		Coping, 640 cubic yards.		Pointed face, 4,000 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	Thomas B. Shanks, Louisville, Ky	$21.10	$3,924.60	$20.70	$4,057.20	$18.90	$12,096.00	$11.40	$45,600.00
2	Salem-Bedford Stone Co., Louisville, Ky	14.00	2,604.00	17.42	3,414.32	14.65	9,376.00	12.54	50,160.00

No.	Name and residence.	Rock face, 2,640 cubic yards.		Special stones, 250 cubic yards.		Grand total cost.
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	
1	Thomas B. Shanks, Louisville, Ky	$11.10	$29,304.00	$28.50	$7,125.00	$102,106.80
2	Salem-Bedford Stone Co., Louisville, Ky	12.41	32,762.40	18.87	4,717.50	103,034.22

ONE-HALF QUANTITY.

No.	Name and residence.	Sills, 93 cubic yards.		Hollow quoins, 98 cubic yards.		Coping, 320 cubic yards.		Pointed face 2,000 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	Thomas B. Shanks, Louisville, Ky	$21.10	$1,962.30	$20.70	$2,028.60	$18.90	$6,048.00	$11.40	$22,800.00
2	Salem-Bedford Stone Co., Louisville, Ky	14.00	1,302.00	17.42	1,707.16	14.65	4,688.00	12.54	25,080.00

No.	Name and residence.	Rock face, 1,320 cubic yards.		Special stones, 125 cubic yards.		Grand total cost.
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	
1	Thomas B. Shanks, Louisville, Ky	$11.10	$14,652.00	$28.50	$3,562.50	$51,053.40
2	Salem-Bedford Stone Co., Louisville, Ky	12.41	16,381.20	18.87	2,358.75	61,517.11

COMMERCIAL STATISTICS.

Cumberland River below Nashville, Tenn., from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Staves	8,948	Logs	900
Wood	8,750	Paving blocks	875
Iron	7,000	Coal	500
Tobacco	3,000	Hogs	475
Lumber	2,606	Salt	424
Cattle	2,250	Bricks	300
Cross-ties	2,142	Hay	305
Grain	1,605	Shingles	100
Horses and mules	1,500	Flour	8
Flour	1,000	General merchandise	12,080

Cumberland River above Nashville, Tenn., from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Sand	19,601	Flour	695
Grain	7,762	Coal	675
Lumber	4,620	Cross-ties	200
Tobacco	3,104	Iron	125
Salt	1,919	Horses and mules	121
Cattle	1,854	Bricks	87
Hogs	1,076	Hay	63
Staves	750	Shingles	23
Wood	700	General merchandise	10,975

Cumberland River above Nashville, Tenn., above Burnside—Smith Shoals—from July 1, 1893, to June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Cotton	30,000	Staves	7,500
Logs	16,000	Coal	2,000
Cross-ties	12,500	Grain	30
Cedar posts	8,970		

List of steamboats (stern-wheel) plying on Cumberland River, Tennessee and Kentucky.

Name.	Length.	Breadth.	Depth.	Tonnage, net.
	Feet.	*Feet.*	*Feet.*	
Huntsville	125	24	4	89.99
Ashland City	120	20	3	94.55
Alex Perry	149.9	28.5	3.5	172.76
A. Frank	98	18	4	70.56
B. S. Rhea	165	27	4.6	293.77
Eleanor	63	16	3.4	34.27
L. T. Rhea	149.8	30.4	3.9	198.54
John T. Carson	85	18.8	3	47.00
John Orm, No. 3	95	17	3.5	95.33
Jas. R. Skiles	68	17.9	3.1	41.43
John W. Hart	168	29	3	215.97
O. E Stockell	103.6	20.3	3	69
Raymond	102.6	22	3	45.16
W. K. Phillips	165	30	4	195.06
Hattie McDaniel	90.5	18	2.5	99.63
Ida	66	17	3.5	15.82
Jas. N. White	147	27	3	77.19
P. H. Staggs	161	28.6	4.4	261.28

B B 7.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

The Caney Fork River rises in the plateau of the Cumberland Mountains, about 18 miles east of Sparta, Tenn., and discharges into the Cumberland River at Carthage, about 116 miles above Nashville, and 209 miles below Burnside, Ky. This stream is about 200 miles long, and has its course and watershed wholly in Tennessee and is navigable during the boating season to Frank Ferry, about 92 miles from its mouth. Under the provisions of act of Congress, approved June 18, 1878, an examination was made in February, 1879, from the mouth of the river to Sligo Ford, 72 miles. (See Report of Chief of Engineers, 1879, pp. 1275–1277.) In compliance with provisions of act

of Congress approved July 5, 1884, the examination of 1879 was extended in 1886 from Sligo Ford to Frank Ferry, a distance of 20 miles. (See Report of Chief of Engineers, 1887, pp. 1768–1771.) During these examinations the channel was found to be obstructed by rock reefs, sand and gravel bars, snags, and overhanging trees.

The fall from Frank Ferry to mouth of river, 92 miles, was estimated to be about 132½ feet; 62½ feet of which is in the upper 20 miles.

The present project, based on the data obtained during these examinations, is to improve the 92 miles of river from Frank Ferry to its mouth by removing the surface obstructions brought down by the annual floods and building necessary riprap dams and training walls, so as to obtain sufficient water for safe navigation for steamboats drawing not more than 3 feet during the usual boating season of about five months, from February to July.

The following appropriations have been made for this work by acts of Congress, viz:

Act of—	
June 14, 1880	$6,000
March 3, 1881	4,000
August 2, 1882	4,000
July 5, 1884	3,000
Aunust 5, 1886	3,000
August 11, 1888	2,500
September 19, 1890	2,500
Total	25,000

No appropriation was made for this river by the act of July 13, 1892.

The amount expended to June 30, 1893, including outstanding indebtedness, was $25,000, the total amount appropriated, which was used in removing the snags and drift brought down by the annual floods, cutting overhanging trees, reducing sand and gravel bars, repairing and building wing dams, etc., and has resulted in securing an improved channel from Frank Ferry to the mouth of river. The work done in clearing the channel will be of great advantage to rafts and flatboats coming down on the so-called "rain tides." No channel work has been carried on since August, 1891, the available funds being exhausted. The engineer property pertaining to this work is placed with other property on the Cumberland River as a measure of economy and safety.

No expenditures were made during the present fiscal year.

The balance of the estimate, $20,228 can be profitably expended during the fiscal year ending June 30, 1896, in channel work, as projected, and if the channel is to be maintained in a safe, navigable condition, a small outlay would be absolutely necessary in each year for the removal of snags, drift, and other surface obstructions brought down by the annual floods, as is common to the mountain streams of this section.

No trips were made during the fiscal year by the steamboats that usually ply at irregular intervals on the Caney Fork River during the season of navigation. As stated in the last annual report—

> The commerce, however, has consisted as heretofore of logs and lumber in rafts, but the merchants state that rafts reach them made of logs from the Cumberland River and its several tributaries, and that they have no means whereby to report separately the number of logs or rafts received from the Caney Fork River.

Estimate for improving Caney Fork River from its mouth to Frank Ferry	$45,228
Amount appropriated	25,000
Amount expended, including outstanding liabilities	25,000

Money statement.

July 1, 1893, balance unexpended	$20.00
July 1, 1894, balance unexpended	20.00
July 1, 1894, outstanding liabilities	20.00
Amount (estimated) required for completion of existing project	20,228.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	20,228.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

APPENDIX C C.

IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENNESSEE, AND FOOT OF BEE TREE SHOALS, ALABAMA.

REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Alabama.
2. Operating and care of Muscle Shoals Canal, Tennessee River.

UNITED STATES ENGINEER OFFICE,
Florence, Ala., July 5, 1894.

GENERAL: I have the honor to transmit herewith annual reports for the works of improvement in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

GEO. W. GOETHALS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

C C 1.

IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENNESSEE, AND FOOT OF BEE TREE SHOALS, ALABAMA (260 MILES).

The river and harbor act of July 13, 1892, contained the following item:

Improving Tennessee River, below Chattanooga, Tennessee. Continuing improvement, five hundred thousand dollars, of which twenty-five thousand dollars may be used in continuing the work at Livingston Point, Kentucky.

Of the amount appropriated as above the sum of $475,000 was allotted to the portion of the river between Chattanooga, Tenn., and the foot of Bee Tree Shoals, Alabama. This allotment was divided as follows:

1. Chattanooga, Tenn., to Decatur, Ala. (180 miles) $75,000
2. Decatur, Ala., to Florence, Ala. (50 miles) 100,000
3. Florence, Ala., to the foot of Bee Tree Shoals (30 miles)..... 300,000

1. CHATTANOOGA, TENN., TO DECATUR, ALA.

The serious obstructions to continuous navigation through this section of the river are Ross Tow-head, Burris Bar, The Suck, the reefs near Bridgeport, Ala., Widow Bar, Guntersville Bar, and Beards Reef.

Ross Tow-head.—This divides the river about 1 mile below Chattanooga into two portions; the right chute, which was generally used during the medium and higher stages, was not navigable during low water, because of rock ledges extending across to the towhead. Under the original project of improvement the left chute was selected for navigation, and to increase the depth of water two riprap dams were built in 1873–'74; one extended from the head about two-thirds across to the right bank; the other, from the foot of the towhead, downstream for a distance of 400 feet. Gravel washed out from above had accumulated at the foot of the longitudinal dam, until at the close of the last fiscal year a gravel bar connected its extremity with the left bank; about 18 inches was the available depth at extreme low water.

Burris Bar.—Williams Island, about 7 miles below Chattanooga, divides the river, the present low-water channel being to the right of the island. This channel is obstructed by Burris Bar, consisting of ledges of rock entirely across the channel; the bar is about 1,800 feet in length, and the available depth at extreme low-water mark is about 1 foot. The left channel is obstructed by a short reef at the head, and by snags and bowlders. No work of improvement has been done here.

The Suck.—The Suck is the name commonly applied to the several rapids and shoals where the river winds in a tortuous route through the mountains below Chattanooga, covering a distance of 8.5 miles, in which the fall is 16.5 feet. The obstructions, separated by pools, are known as Tumbling Shoals, The Suck, The Pot, The Skillet, and The Pan, and are formed by rock reefs and bowlders, and by projecting rocky points from both shores, which contract the waterway. At low-water stages Tumbling Shoals and The Skillet are especially difficult to navigate; as the river rises The Suck, including Suck Point, becomes difficult to stem, while The Pot and The Pan are very great obstructions during high stages.

The channel work carried on in 1869 and 1870 at The Suck and The Pot, and in 1889 at The Pan, consisted in widening the cross section by the removal of bowlders, projecting rocky points, and overhanging trees, and has resulted in somewhat diminishing the velocity of the current, but upstream navigation is still attended with delays caused by the necessity of laying lines and warping vessels over the swiftest places.

Bridgeport Reefs.—The river near Bridgeport, Ala., is divided into two portions by an island about 5 miles long, the left-hand chute being the steamboat channel. The obstructions here consisted of a gravel deposit near the head of the island, and limestone reefs above the railroad bridge and near the foot of the island. At extreme low water the available depth was about 18 inches; the fall is about 1 foot to the mile.

Widow Bar.—This obstruction, another rock reef, is about 2½ miles below Bridgeport Island, and is about 2,800 feet in length, the depth of water varying from 1.5 to 2.5 feet.

Guntersville Bar.—The river just above Guntersville is obstructed by bowlders and loose detached rock, making the steamboat channel very tortuous and difficult of passage during low-water stages. The navigation of this part of the river is further impeded by a rock ledge 300 feet long, on which there was a minimum depth of 1 foot of water.

ds Reef.—This obstruction is about 3 miles below Guntersville
g, and consists of a rock ledge crossing the river normal to its
with a gap near the right bank which is used as a steamboat
l, but which was obstructed by detached rocks.
r obstructions of minor importance are said to exist between
sville and Decatur, but their exact nature and extent are not
, as a survey of this portion of the river has never been made.
approved project for this section of the river is "to remove
:tions so as to secure a depth of at least 3 feet at low water."
:o the close of the fiscal year ending June 30, 1893, there had
:pended the sum of $79,002.30. This expenditure resulted in
ting the discharge through the mountains below Chattanooga
medium and high-water stages by removal of bowlders and trees
-water mark; straightening channel through and below Tum-
hoals, and in reducing the fall at this locality and the removal
:hed rocks in Beards Reef Channel, besides making an instru-
survey of 32 miles of river.
ı the relative velocity and direction of the currents through the
ıtes at Ross Tow-head at various stages of the river it was evi-
ıat a sufficient depth at low water could not be maintained in the
ınnel to the left of the tow-head, and this, together with the fact
e best water above and below the obstructions was along the
)ank, led to the adoption of the new channel along the right
This channel is to be when completed 150 feet wide, straight
hout, from deep water above to deep water below, and will have
lepth at low water, the amount excavated being determined by
ı of gauges located along the line of excavation. The old chute
ı closed by a riprap dam from the head of the island, formed by
:avated material and made tight by gravel backing.
work is being done under contract with W. A. Kirk, of Madison,
The necessary drilling was done by hand from platforms when
able, and when season and stage of water permitted by the men
ıg on the river bottom. The ledges were blasted and the mate-
ıs subsequently removed by a dipper dredge. The low-water
extending over a longer period than usual, considerably delayed
dging, and the work could not be completed, so that the con-
as extended to July 1, 1894. After the dredge had removed the
from the channel it was ascertained that a few isolated points
ed above the proper grade, requiring more drilling and blasting,
this purpose the river was too high to prosecute the work prop-
advantageously, and the contract was extended to December
t. Work was resumed on June 18. During the fiscal year the
:tor has removed 2,604.7 cubic yards of gravel, 2,718.1 cubic yards
,400 linear feet of the old wing dam, and has completed the rip-
n closing the left chute.
ork has been done during the fiscal year at Tumbling Shoals; some
ıg is still necessary to complete the contemplated improvement.
ı it was not expected to materially reduce the velocity of the
: at this locality, navigation upstream is somewhat easier than
y, whereas the dangers attending downstream navigation have
aterially, if not entirely, remedied.
improvement of the channel at and near Bridgeport by hired
ras prosecuted until well into the fall, when high water made
l of plant necessary. From the bar at the head of the island
ere removed 21,512 cubic yards of sand and gravel resulting in
leted channel 120 feet wide and averaging about 6 feet deep.

This increased depth was given to allow for drawing off the water that will result when the bars below and in the same chute are removed. Through the bar above the railway bridge only one cut was made by the dredge when operations were suspended. There were removed 1,590 cubic yards of loose rock and 5,920 cubic yards of other material, principally clay. The channel formed here has a total length of 1,800 feet, width 40 feet, depth 5 feet.

The contract with Neely & Smith for removing material at Gunters Reef was extended to November 15, 1894, the contractors having been unable to do any work, owing to sudden and frequent fluctuations in depth of water, which resulted in twice washing out their temporary tripod dam before any work could be done; this dam was used to deflect the current so that the men could stand on the river bottom to drill. On application of contractors and by authority of the Chief of Engineers they proposed to complete their contract by the aid of a United States dredge not in use, making a reasonable allowance for same. The dredge was started to that locality the last of June.

During the year liabilities to the amount of $19,876.77 were incurred, leaving an available balance of $12,967.94 at end of fiscal year, as follows: Ross Tow-head, liabilities $18,685.28, available balance $8,785.56; Bridgeport and Gunters Reef, liabilities $1,191.49, available balance $4.182.38.

2. DECATUR, ALA., TO FLORENCE, ALA.

The principal obstructions are the Muscle Shoals, extending from deep water at Browns Ferry to deep water at Florence, a distance of 38 miles, only 8 of which are navigable, and embracing Elk River Shoals, Big Muscle and Little Muscle shoals.

The object of the improvement is to make continuous navigation around these obstructions by means of a lateral canal.

The approved project according to which work is being done, based upon the survey of 1872 and somewhat modified in 1877, is—

(1) To enlarge, rebuild, and straighten the old canal around Big Muscle Shoals, built by the State of Alabama in 1831-1836 and abandoned in 1837, by constructing a canal 14.5 miles long, having 9 locks, with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long and 60 feet wide, with a depth of 5 feet of water on the miter sills.

(2) To construct at Elk River Shoals a canal 1.5 miles long, with two locks, having lifts of 12 feet and from 8 to 11 feet, respectively, and of same dimensions as the locks at Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed rock of the river, and to construct stone wing dams and retaining walls to contract the waterway and to check the velocity of the current at certain points; as modified in 1890, to construct a lateral canal on the north bank 15,000 feet long, with a guard lock at the head and a lock at the foot, having a lift of 12 feet, and of the same dimensions as the locks at Big Muscle Shoals.

Up to the close of the fiscal year ending June 30, 1893, the sum of $3,172,011.64 has been expended, with the following results:

The two divisions of the canal were sufficiently completed to permit navigation at all stages of the water; channels were excavated through

rns Island Chute, Gilchrists Chute, and Nance Reef; houses were
; for occupancy of lockmasters and assistants; a dredge and tow-
were constructed, and a large amount of plant purchased for use
e canal.
ıring the fiscal year the following work was done:
ıder contract with H. T. Morrison & Co., of Petersburg, Va., pat-
s and 38 iron-balanced valves, to replace the wooden slide valves
erly used in filling and emptying culverts, were delivered and put
ace by hired labor at all the locks, except Lock B, where they will
ut in as soon as stage of water permits. These valves swing on a
ical axis, and have a preponderance on the downstream leaf
h was considered ample to carry the valve entirely open as soon
was started from its seat. This result, however, has not been
zed, for though the valve will open by itself when started from its
, it comes to rest at an angle of about 45° with the axis of the cul-
and returns to this position if left free to move after being opened
s full extent. Moreover, when the valve is pushed beyond a posi-
parallel to the axis of the culvert it moves on until it reaches a
tion at 45° to the axis, but at the opposite side. Notwithstanding
the valves are very satisfactory, and can easily be operated by
man.
ıe United States grounds at Locks 2, 3, and 4 were inclosed by
:onstruction of 4,800 feet of fencing.
ıny repairs were made to dredges, steamboats, locomotives, and
r plant, and all Government property was cared for and kept in
order.
ıere were expended during the year $17,407.63, including outstand-
iabilities.

3. FLORENCE, ALA., TO THE FOOT OF BEE TREE SHOALS.

lbert and Bee Tree shoals, beginning about 22 miles below Flor-
, form the principal obstructions to navigation during low-water
:s. These shoals, which may be considered as forming one con-
ıus obstacle, are 8 miles in length, with a total fall of 25 feet at
water, and at this stage the depth in the channel is about 1.5 feet.
islands divide the river through the shoals longitudinally, and
work heretofore carried on for the improvement of navigation con-
d in building riprap dams, which, in connection with the islands,
ned the water to the chute along the north bank. Increased depth
obtained by channel excavation. This method does not give
lts adequate to the present needs of commerce.
ıe project adopted in 1890 contemplates the construction of a
al canal on the south bank of the river 7.8 miles long, 150 feet
at the water surface, with a depth of 7 feet. A combined lock,
a total lift of 25 feet, was originally intended to be placed at the
r end and a guard lock at the head for use when necessary at very
water, the locks to be 80 by 350 feet, with a depth of 6 feet of
r on the miter sills at extreme low water.
ıis project was modified after the detailed surveys of 1891 were
ıleted by substituting for the combined lock two locks of 12 and
:et lift, respectively, at extreme low water, and separated by a
1 mile in length, and again modified in 1892 by the substitution of
lock having a lift of 25 feet for the two locks contemplated in the
fication of 1891.
ıder the project $48,921.82 were expended up to the close of the

fiscal year ending June 30, 1893, in making survey of location for canal, examination of foundations for lift lock, and in purchases of lands necessary for the improvement.

Work done during the fiscal year ending June 30, 1894, was as follows:

The excavation was commenced by using wheel scrapers and the material was deposited on the sides of the lock pit, forming a levee to keep out ordinary high water; this levee was subsequently extended around the area used for stone yard. In January the excavation reached water line in the interior of the pit and the material was of such a nature that teams could not work advantageously, so the wheel scrapers were abandoned. A combined dredge and towboat, the *John Gaston*, was then brought up from Memphis, Tenn. It was provided with a clam-shell dipper and a suction pump for removing sand. The intention was to cut a passageway from the river to the lock pit and to remove the material in the lock pit, consisting of sandy loam and quicksand, by means of the pump. After removing about 1,600 cubic yards of earth in making the cut from the river to the lock pit, but without accomplishing anything toward excavating the lock pit, this method was abandoned and the dredge removed from the work in May. Since then a wheelbarrow force has been employed to the end of the fiscal year.

A row of piles, at distances of 4 feet apart and 7 feet from the back of the lock walls, has been driven entirely around the lock site and presumably to rock. A second row of piles, 8 feet apart and to which the top of the first row was to be tied, was driven along the south side and 90 feet from the center line of lock pit. These were driven so as to bring the tops of the piles to about reference (54.0), and were intended to be one support for a traveling crane to be used in laying stone. This was subsequently abandoned and this outer line of piles removed.

To confine the quicksand sheeting was driven inside of the first row of piles above referred to and secured at top to a waling strip bolted to the piles. This sheeting was at first prepared in sections 3 inches thick, 6 to 8 feet wide, and about 14 feet long, composed of two layers of 12-inch planks placed at right angles to each other, and these sections driven by means of pile-driver and water jet, presumably into gravel. This method was abandoned and the sheeting, consisting of planks 3 inches thick and 14 to 16 feet long, was driven. A second row of 2-inch sheeting was driven inside of this to cover the openings in the first row.

An 8-inch centrifugal pump was erected in the lock pit to drain the area from seepage and rain water.

A timber dock was erected at the river bank on piles to facilitate the unloading of stone from barges. This dock was connected with the stone yard by a standard-gauge track. A stone planer was placed in position for cutting the stone. It consisted of two iron cylinders about 6 feet long, placed parallel to each other, the one in rear at a slightly lower level than the one in front. The cutting knives are placed spirally around these cylinders; those on the first cylinder are scabbling tools, those on the second the finishing tools. The stone is placed on a platform which is moved by rack and pinion and passes under the revolving cylinders, which can be raised or lowered vertically. The machine, has not given a satisfactory finish, even for backing, and stones are worked over after being passed through the planer. The traveling crane, which was purchased for laying stone in the wall, has been erected in the stone yard and is used for handling and piling stone.

The necessary derricks and blacksmith shops have been erected and a track (standard gauge) laid from the lock site to the Birmingham, Sheffield and Tennessee River Railroad Company's track at Riverton, a distance of about half a mile.

The limestone quarry situated on the river bank about 3 miles below Florence was selected for procuring stone for the work. The Knox system of quarrying has been in use with satisfactory results, but the quarries have not been worked economically nor advantageously.

At the close of the fiscal year 46,450 cubic yards of earth have been removed from the lock pit; 4,997 cubic yards of stone delivered on the ground, of which amount there have been prepared for the walls 631 cubic yards of fine-pointed stone, 174 cubic yards of rough-pointed stone, 18 cubic yards of rock-face stone, and about 2,356 cubic yards of backing ready for the wall. In addition to the foregoing 685 piles have been driven, including those used in dock and for support of traveling crane, and 1,063 feet of the lock pit inclosed by sheeting.

A tract of 28.91 acres of land needed on the line of the canal was purchased for the United States, the deed recorded, and cession of jurisdiction made by the governor of the State. New bench marks were established at lower end of canal and a check line run over the entire line of canal to the head, and bench marks located for use in establishing datum plane for upper lock.

Appropriations for improving Tennessee River below Chattanooga, including surveys, have been made as follows:

March 2, 1827	$200.00	March 3, 1879	$210,000.00
August 30, 1852	50,000.00	June 14, 1880	300,000.00
June 9, 1860	1,350.00	March 3, 1881	250,000.00
June 12, 1860	1,406.94	August 2, 1882	250,000.00
March 3, 1871	80,000.00	July 5, 1884	350,000.00
June 10, 1872	50,000.00	August 5, 1886	262,500.00
March 3, 1873	100,000.00	August 11, 1888	250,000.00
June 23, 1874	100,000.00	September 19, 1890	475,000.00
March 3, 1875	360,000.00	July 13, 1892	500,000.00
August 14, 1876	255,000.00		
June 18, 1878	300,000.00	Total	4,145,456.94

Money statement.

July 1, 1893, balance unexpended		$477,326.27
June 30, 1894, amount expended during fiscal year		57,400.91
July 1, 1894, balance unexpended		419,925.36
July 1, 1894, outstanding liabilities	$30,698.26	
July 1, 1894, amount covered by uncompleted contracts	289,988.08	
		320,686.34
July 1, 1894, balance available		99,239.02

Amount (estimated) required for completion of existing project 5,707,931.81
Amount that can be profitably expended in fiscal year ending June 30, 1896 .... 2,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Articles.	Between Chattanooga, Tenn., and Decatur, Ala., year ending December 31—			Between Florence, Ala., and Paducah, Ky., year ending December 31—		
	1891.	1892.	1893.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Iron	1,125	3,415	3,726	8,636	10,712	11,184
Staves	2,500	2,732	3,420	3,706	4,063	6,885
Lumber	1,932	30,818	37,155	26,957	64,371	81,377
Cotton	1,809	1,614	827	5,566	3,970	2,457
Peanuts				4,473	3,339	1,755
Live stock	311	408	452	1,786	2,639	2,738
Hoop poles				3,086	2,912	87
Grain	4,281	4,552	3,780	16,546	15,185	10,787
Flour	557	698	792	6,240	5,212	7,760
Cotton seed	188	154	227	1,095	510	111
Sand				2,256	1,526	701
General merchandise	5,243	7,807	7,218	32,553	32,145	27,873
Logs	41,626	25,921	31,880	184,563	50,818	61,470
Railroad ties				38,374	92,975	168,317
Total	59,572	78,119	89,477	335,836	290,377	383,502

List of steamboats (stern-wheel) plying on the Tennessee River below Chattanooga, Tenn.

Name.	Length.	Breadth.	Depth.	Tonnage.
Between Chattanooga, Tenn., and Decatur, Ala.	*Feet.*	*Feet.*	*Feet.*	
Maude			2.5	23.03
B. F. Young	120	24	4	160.68
R. C. Gunter	153	28	4	337.30
Wyeth City	120	21.5	4.8	138.96
J. R. Hughes	98	17	3.5	95.15
Pinhook	94	18	3	90.60
R. T. Coles	118	24.5	4.5	134.91
City of Chattanooga	134	27.8	3.6	167.60
J. P. Kindrick	111	20	3.5	128.71
Rockwood	130	25.6	4	150.52
A. J. Duncan	150	32	4	460
Below Florence, Ala.				
City of Savannah	190	32	5	335.50
City of Sheffield	180	32	5.5	750
City of Paducah	183	37	5.25	700
W. F. Nesbit	212	36	6.5	680
Clyde	185	33	6	580
A. S. Willis				133
Gus Genin	120	20	4	130
C. Smith	182	29	3.5	350
City of Chattanooga	134	27.8	3.6	167.60
J. P. Kindrick	111	20	3.5	128.71
Edwin Wood				
J. N. Hook	110	19.2	3	55.95
Dick Clyde	96	17.4	3.9	76.84
R. A. Speed	124	22	4.2	140.57
Al. Martin	112	23.6	4	98.68
Maggie Belle	95.6	18.4	3.6	52.81
Rockwood	130	25.6	4	150.52
A. J. Duncan	150	32	4	460
B. F. Young	120	24	4	160.68
R. C. Gunter	153	28	4	337.30
Wyeth City	120	21.5	4.8	138.96
R. T. Coles	118	24.5	4.5	134.91

CC 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal, which had been in course of construction since 1875, was formally opened to public traffic on the 10th day of November, 1890.

The canal consists of two sections, known as the Elk River Division and the Muscle Shoals Division, being named thus from the shoals of

he same names on the Tennessee River around which the two sections ere constructed. The Elk River Division is 1½ miles long, not less han 100 feet wide, and has two locks, known as Locks A and B, each 0 by 300 feet, with a total lift of 23 feet. The Muscle Shoals Division eginning about 8 miles below Lock B, is 14½ miles long, from 70 to 100 eet wide, and has been constructed by rebuilding and enlarging the ld canal built by the State of Alabama, 1831–1836. This canal was sed for one season, but the obstructions in the river above and below imited navigation to certain stages of the water. It was operated for year, after which, no funds being appropriated for its maintenance, t was disused and fell into decay.

The lower division of the canal contains nine locks of the same dimensions as those in the upper division, viz. 60 feet wide and 300 feet long, ith a total lift of 85 feet.

During the past fiscal year the canal was kept in working order and o delay in traffic occurred. The locks, buildings, and grounds were ared for and kept in good condition, the entire line of embankment as patrolled daily for the purpose of detecting leaks, a large number f which were closed with broken stone, gravel, and clay.

Work done during the year was as follows:

In order to protect the embankment and railway from injury during reshets, the water from First Creek having caused much damage, the ld dry wall on the south side of the canal just above Lock 1, which ad caved in, was removed, and a new wall capable of withstanding the arth pressure was constructed in its place. The dimensions of this wall re as follows: Length, 276 feet; mean height, 15 feet; width at bottom, feet; width at top, 3 feet. This work involved the excavation of 1,466 ubic yards of earth and the removal of 73 cubic yards of stone from he old revetment; 46 cubic yards of earth were applied in grading the ank back of the dry wall.

The north line of the canal, between Locks 1 and 2, was straightened y dredging, and by removing a large number of stumps and logs, giving the canal a greater width at this point, which was needed to facilitate the passage of vessels.

About 10 cubic yards of broken stone, which had accumulated in the pper end of chamber at Lock 2, were removed by hand.

The old dry wall below Lock 2 was repaired, and a short one built to rotect the bank and spring on the north side of canal.

There were dredged from the mouth of Bluewater Creek 875 cubic ards of gravel, which were deposited at different points along the line of he canal, to be in readiness for repairing leaks. The upper abutment f Bluewater bridge was protected from scour by placing against it on he river side 20 cubic yards of heavy riprap. The old unused quarry uarters at Lock 4 were moved to Lock A, where they were put up for he storage of such property as it was considered advisable to keep on and for needed repairs at that division.

A turbine wheel and air compressor were erected and coupled ogether at the machine shop at Lock 6, and piping placed to connect he air compressor with the receiver in boiler room of machine shop. his compressed air plant for supplying power to the machine shop roved very efficient, and will save the Government much expense in he matter of fuel, labor, etc.

A wall was built around the spring at Lock 6, which supplies the Government buildings with water, and they were connected with the spring y laying 1,800 feet of pipe, thus saving the constant services of aborers employed in carrying water. An old, useless negro shack was orn down and the site graded.

A large quantity of drift which had accumulated against the upper side of the aqueduct piers was removed.

The gate walk ways at Locks 3, 4, and 5 were repaired and new ones placed at Locks 1, 2, and 8.

A new valve shaft was placed in southeast valve at Lock 6, repairs made to valves at Locks 3, 7, 8, and 9, to render them serviceable until new ones could be substituted, and two old wooden valves at Lock 5, one at Lock 6, and two at Lock 8, were replaced with new iron ones.

Two new oak miter posts were put in lower gate at Lock 1, and two in lower gate and two in upper gate at Lock 2. A new spar platform was made and placed in southwest gate at Lock 8.

Floats were placed on gates at Locks 6, 7, 8, and 9; the maneuvering gear at Lock 5 was repaired; timber covers erected over valve gears at Locks 1, 2, 5, 6, 7, 8, and 9; iron work painted at Locks 1, 2, 3, 4, 5, 7, 8, and 9.

The grade of the railway at the upper end of Second Creek weir was reduced, the spur track at Lock 5 was moved and lengthened to give better access to spoil banks, and 50 new ties were put under spur track below Lock 6.

Two movable gratings were placed in upper openings of upper culverts at Lock 1.

Three new valves with hoisting irons were placed in the dam at Bluewater Creek, and hoisting irons were put on valves of dams at Second Creek, Helltown Branch, Douglas Branch, and Four-Mile Creek.

The United States grounds at Lock 2 were fenced.

The lock-master's and watchman's houses at Lock 5, veranda of foremen's house at Lock 6, and watchman's house at Lock 8 were repainted.

There were taken from the bed of the canal below Lock 6, 75 cubic yards of gravel, which were placed on the walks around the foremen's house.

A large number of leaks and washouts between Locks 2 and 8 were stopped, nearly 300 cubic yards of stone, gravel, earth, and clay being used for this purpose.

The total quantity of material removed by dredge and otherwise was 42,800 cubic yards, as follows:

	Cubic yards.
Above Lock 1	2,640
Between Locks 1 and 2	38,180
At Lock 2	10
Between Locks 2 and 3	45
Between Locks 3 and 4	875
Between Locks 4 and 5	575
Between Locks 5 and 6	125
Between Locks 6 and 7	75
Below Lock 9	275
Total	42,800

There were also removed from the upper division of the canal, by passing through the drift sluice, 1,275 logs and a large quantity of drift.

The longitudinal dam was strengthened by placing upon it 63 cubic yards of stone, and 3 buoys were made and fitted with chains and anchors to mark the channel.

The lands and buildings at Miltons Bluff, which had been leased, were given up, and the Government property was stored in two buildings which had been erected at Lock A for the purpose. A stable for Government mules was also built.

A new clutch was put on lower gate at Lock A, hydraulic machinery repaired, two new wooden miter cushions were put in lower gate at Lock B, and machinery, maneuvering gear, snubbing posts, etc., repainted.

A cylinder rod on upper left hand culvert at Lock A was repaired, dry stone piers built under the assistant lock-master's house, and gravel filled under and around the house. The drainage ditch was extended 100 feet.

A trench was dug between Locks A and B and filled with gravel, with a view to stop leaks caused by crawfish and the roots of trees. The drain, for carrying off stagnant water from the sloughs, and all the ditches were cleaned.

The walks of both lock-master's houses were filled with gravel. Grass, weeds, underbrush, &c., were kept cut from the banks of the canal along its whole extent.

The Bucyrus dredge was repaired and repainted; fan-tail built at stern to facilitate towing by steamer; centrifugal flushing pump removed, and duplex Gordon pump, with outside packed plungers, substituted; wainscoting put up in engine room; bulkhead built separating pump room from boiler room; bucket scraper erected and iron work scraped and repainted with graphite paint, placing the dredge in first-class condition.

Five barges were dry-docked in the aqueduct and calked. A steam derrick with engines and 6-inch centrifugal pump for sand and silt was erected on barge, and used in removing sediment from about lock gates where dredge could not operate; new rudder made and placed on steam tug *McFarland*, strengthening braces put under upper guards of steamer *Colbert*, dredge *Harwood* repaired, worn parts of locomotives replaced with new, an 8-wheel flat car built, the road between the United States reservation and the public road repaired, and a great number of minor repairs made to machinery, tools, appliances, buildings, and plant in general.

The cost of the above work was reduced to a minimum through the policy adopted of appointing skilled mechanics, or persons who have had experience that may be useful to the Government, to the positions of lock-masters and assistant lock-masters. Among these are two stone-cutters, one mason, one painter, one carpenter, one transitman, one railroad boss, one quarryman, one machinist, one pilot, one commissary, and two foremen familiar with the management of laborers.

The services of these employés are utilized at any time or any point along the line when or where needed.

Abstract of allotments.

November 28, 1890	$40,000.00
July 1, 1891	31,792.04
July 1, 1892	45,232.90
July 1, 1893	60,975.19
Total	178,000.13

Estimate of funds needed from appropriation for operating and care of canals and other works of navigation, indefinite, to be applied to current expenses in operating the Muscle Shoals Canal, from July 1, 1894, to June 30, 1895.

Amount required for fiscal year ending June 30, 1895	$65,000.00
Balance remaining from allotment of preceding year, exclusive of outstanding liabilities	1,227.37
Additional allotment required for fiscal year ending June 30, 1895	63,772.63

To be expended as follows:

1 assistant engineer, at $200 per month	$2,400.00
1 master mechanic, at $100 per month	1,200.00
1 overseer, at $100 per month	1,200.00
1 clerk, at $100 per month	1,200.00
11 lock masters, at $75 per month each	9,900.00
11 assistant lock masters, at $40 per month each	5,280.00
1 locomotive engineer, at $60 per month	720.00
1 engineer at machine shop, at $60 per month	720.00
1 telephone lineman, at $50 per month	600.00
2 blacksmiths, at $75 per month each	1,800.00
1 carpenter, at $80 per month	960.00
1 overseer, at $80 per month	960.00
30 laborers, at $30 per month each	10,800.00
Dredging and towboat crews, $800 per month	9,600.00
Subsistence, $525 per month	6,300.00
Repairs of dredge, plant, material, and contingencies	11,360.00
Total for year	65,000.00

Statement of traffic through the Muscle Shoals Canal during the calendar year ending December 31, 1893, compared with traffic during years ending December 31, 1891 and 1892.

	Year ending December 31—		
	1891.	1892.	1893.
Steamers ..... number	24	60	95
Barges ..... do	19	55	69
Rafts ..... do	6	5	9
Miscellaneous craft ..... do	9	12	35
Tonnage ..... tons	2,420	4,476	12,612
Lumber ..... do	633	962	3,543
Cotton ..... do	62	255	59
Grain ..... do	840	404	280
Flour ..... do	54	11	591
Oak extract ..... do	600	800	.....
General merchandise ..... do	47	2,119	3,110
Logs ..... do	225	471	9,049
Iron ..... do	520	610	.....
Coal ..... do	150	150	4
Total	3,131	5,782	16,636
Passengers ..... number	171	936	3,506

The above is exclusive of supplies carried by Government steamers.

Detailed expenses incurred for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1894.

Month.	Office and administration.			Operating, care, repairs, etc.			
				Locks A and B.			
	Salaries.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.
1893.							
July	$280.00	.....	$280.00	$375.00	$83.48	.....	$458.48
August	280.00	$24.56	304.56	375.00	100.50	.....	475.50
September	280.00	.....	280.00	420.00	142.86	$125.75	688.61
October	280.00	.....	280.00	395.00	123.10	.....	518.10
November	280.00	.....	280.00	395.00	85.65	.....	480.65
December	280.00	.....	280.00	486.67	99.27	40.00	625.94
1894.							
January	280.00	.....	280.00	475.00	151.40	.....	626.40
February	280.00	.....	280.00	475.00	77.13	26.00	578.13
March	280.00	.....	280.00	475.00	69.42	.....	544.42
April	280.00	8.80	288.80	385.00	86.19	.....	471.19
May	280.00	.....	280.00	385.00	72.47	.....	457.47
June	280.00	.....	280.00	385.00	114.16	39.77	538.93
Total	3,360.00	33.36	3,393.36	5,026.67	1,205.63	231.52	6,463.82

Detailed expenses incurred for operating and care of Muscle Shoals Canal, etc.—Cont'd.

Month.	Operating, care, repairs, etc.				Grand total.
	Locks 1 to 9.				
	Labor.	Subsistence.	Supplies.	Total.	
1893.					
July	$4,508.94	$564.04	$509.56	$5,582.54	$6,321.02
August	4,000.02	625.19	891.71	5,516.92	6,296.98
September	3,704.73	630.77	418.53	4,754.03	5,722.64
October	3,276.48	616.88	454.73	4,348.09	5,146.19
November	3,185.05	607.88	330.72	4,123.65	4,884.30
December	3,004.50	619.27	746.19	4,369.96	5,275.90
1894.					
January	3,186.17	632.14	304.02	4,122.33	5,028.73
February	3,611.83	600.18	550.90	4,762.91	5,621.04
March	3,255.58	587.75	314.16	4,157.49	4,981.91
April	3,246.75	621.11	397.14	4,265.00	5,024.99
May	3,252.00	557.02	228.90	4,037.92	4,775.39
June	3,065.25	596.19	213.17	3,874.61	4,693.54
Total	41,297.30	7,258.42	5,539.73	53,915.45	63,772.63

APPENDIX D D.

IMPROVEMENT OF OHIO RIVER AND OF MUSKINGUM RIVER, OHIO.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating snag boat on Ohio River.
3. Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.
4. Movable dam in Ohio River below mouth of Beaver River, Pennsylvania.
5. Ice harbor at mouth of Muskingum River, Ohio.
6. Muskingum River, Ohio.
7. Operating and care of locks and dams on Muskingum River, Ohio.
8. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION.

9. For ice harbors at Cincinnati, Ohio.

HARBOR LINES.

10. Ohio River from Martins Ferry to Bellaire, Ohio.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 9, 1894.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1894.

I was assisted by First Lieut. William C. Langfitt, Corps of Engineers, U. S. Army, from August 30, 1893.

* * * * * * *

Very respectfully, your obedient servant,

AMOS STICKNEY,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

D D 1.

IMPROVEMENT OF OHIO RIVER.

Statement of amounts and dates of all appropriations for this work.

Act of Congress.	Appropriations.	Allotments.	Remarks.
Mar. 3, 1827	$30,000.00	.....	
Mar. 3, 1835	50,000.00	.....	
July 2, 1836	20,000.00	.....	
Mar. 3, 1837	60,000.00	.....	
July 7, 1838	50,000.00	.....	
June 11, 1844	100,000.00	.....	
Mar. 3, 1847	6,479.25	.....	
Aug. 30, 1852	90,000.00	.....	
June 23, 1866	.....	$172,000.00	Improving Mississippi, Missouri, Arkansas, and Ohio rivers.
Do	.....	80,000.00	Snag boats and apparatus for improving Western rivers.
Mar. 2, 1867	100,000.00	.....	
July 25, 1868	.....	85,000.00	Repair, preservation, extension, and completion of river and harbor works.
July 11, 1870	50,000.00	.....	
Mar. 3, 1871	50,000.00	.....	
June 10, 1872	200,000.00	.....	
Mar. 3, 1873	200,000.00	.....	
June 23, 1874	150,000.00	.....	
Mar. 3, 1875	300,000.00	.....	
Aug. 14, 1876	175,000.00	.....	
June 18, 1878	300,000.00	.....	
Do	50,000.00	.....	Harbor of refuge at or near Cincinnati.
Mar. 3, 1879	250,000.00	.....	
June 14, 1880	250,000.00	.....	
Mar. 3, 1881	350,000.00	.....	
Mar. 21, 1882	100,000.00	.....	Continuing work on Davis Island Dam.
Aug. 2, 1882	350,000.00	.....	
Do	16,000.00	.....	Harbor of refuge near Cincinnati, Ohio.
July 5, 1884	600,000.00	.....	
Do	17,000.00	.....	Do.
Aug. 5, 1886	375,000.00	.....	
Aug. 11, 1888	380,000.00	.....	
Sept. 19, 1890	300,000.00	.....	
July 13, 1892	360,000.00	.....	
	5,329,479.25		
Deduct amounts transferred to other works	125,168.48	.....	
Total	5,204,310.77	337,000.00	

The general plan for improving the navigation of the Ohio River, now in process of execution, is to secure additional depth at islands and bars by the construction of low dams across chutes, and by building dikes where the river is wide and shallow, so as to confine the flow to a smaller cross section, and by dredging. A radical improvement of the upper part of the river has been commenced by the construction of a lock and movable dam at Davis Island, 5 miles below Pittsburg, and work on another lock and dam has been commenced just below Beaver, 29½ miles from Pittsburg. A snag boat and two dredges, belonging to the United States, are constantly employed when funds are available and the stage of river permits, in taking out snags and wrecks and in dredging away gravel and rock obstructions that can not otherwise be removed.

At the commencement of the year the following projected works were unfinished:

Quarters for employés at Davis Island Dam; 2 dikes at Logstown Bar, 18½ miles below Pittsburg; 4 dikes and 1 dam at Clusters Islands, 52 miles below Pittsburg; excavation of Rock Bar, at mouth of Licking River, 466½ miles below Pittsburg; 2 dikes and 1 dam at French Island, 761 miles below Pittsburg; 2 dikes at Scuffletown, 767 miles

elow Pittsburg; 1 dike at Tradewater Bar, 862 miles below Pittsurg; 2 dikes at and near Mound City, Ill., 959 miles below Pittsburg.

The following works were in progress during the year:

Quarters for employés at Davis Island Dam.—Under contract with Villiam Wolfshafer, work on these quarters was begun in August, 893, and completed in December, 1893. These quarters are conveniently located on Davis Island and were much needed.

Dam between Davis and Neville islands.—This dam was repaired in ugust where it had been slightly injured. Material expended: 24½ uare yards of stone paving and 18 square yards of stone revetment.

Dam between foot of Neville Island and Towhead, 11 miles below Pittsrg.—This dam was extended toward the towhead a distance of 583 et, to close an opening eroded by the river between the foot of the am and the towhead. This work began in September and was cometed in November, 1893. The materials used were purchased in open arket and the work done by hired labor.

Material expended.

hite-oak lumber	feet, B. M..	53,354
ne lumber	do....	124
mlock lumber	do....	43,094
ift bolts	pounds..	6,929
ikes	do....	96
rner band	do....	166
rap stone	cubic yards..	1,160
cavation made	do....	360

Dikes at Logstown, Pa., 18½ miles below Pittsburg.—Work at this ace, in accordance with the plan recommended by the Board of ngineers, was resumed on the main cross dike and training dike in eptember, 1893, and was suspended for the season in January, 1894. wenty-one hundred and eighty-five cubic yards of stone were placed the dike and 3 boat loads purchased to complete the 125 feet of aining dike unfinished, but the stage of water prevented placing the one as contemplated. With the exception of this 125 feet the main nd training dikes are practically completed. A survey is in progress determine what changes have taken place. The closing of the infeor shore channel and dredging out of a straight channel across the ar, which were parts of the original plan, but omitted in the recomendation of the Board on account of the opposition of the coal men, ill, in my opinion, have to be accomplished to render navigation safe nd easy at this point. At the close of the year work had not been sumed. An extract from the report of Mr. William Martin, assistant gineer in local charge of this work, is appended.

Dikes, etc., at Clusters islands, 52 miles below Pittsburg.—A contract as made with L. Cramer & Son, dated June 20, 1893, approved June , 1893, work to be completed December 31, 1893, for the construction 4 dikes, 1 dam, and shore protection at this place. Work was begun August, 1893, and suspended for the season in December, 1893. The ntractors confined their work to Dike No. 4 and the dam between the ands. The following amounts of material were expended on the dike d dam respectively:

Accepted and paid for.

Material.		Dike No. 4.	Dam
es	number..	188	135
nber	feet, B. M..	9,360	.....
lts	pounds..	640	.....
one	cubic yards..	1,344.7	1,124.3

In addition to the above the following material was delivered, but not being properly placed has not been accepted:

Material.		Dike No. 4.	Dam.
Piles	number..	6	.....
Timber	feet, B. M..	240	.....
Bolts	pounds..	16	.....
Stone	cubic yards..	78.9	145.9

The contractors failed to furnish proper plant, materials, and labor, and have shown but little energy in executing the work. It was, however, deemed to the best interests of the United States to extend their contract to November 30, 1894, under supplementary agreement giving the United States power to enforce proper progress for future work. The contractors resumed work under the modification in April, 1894, and at the close of the year the work is in progress, the following additional material having been expended:

Stone	cubic yards..	2,378
Piles	number..	254
Timber	feet, B. M..	7,288
Bolts, etc	pounds..	481

Work has been commenced on all of the structures, and it is hoped they will be finished this season.

The works are not yet sufficiently far advanced to have their proper effect on the depths of the river channel.

Rock Bar, at the mouth of Licking River, 466½ miles below Pittsburg.—As stated in the last annual report, the present project contemplates the continuance of the excavation of this bar by submarine blasting and subsequent dredging. The steam drilling scow was completed and began work in September and continued in operation until November, when the funds for this work became exhausted. After blasting, the material was dredged out and deposited behind the dike at Cullums Bar, 5 miles below. The method adopted has proved very economical, even when this season's work has been charged with the total cost of the plant. The amount of material removed was 4,215.5 cubic yards.

The work was under the immediate supervision of Mr. R. R. Jones, assistant engineer, an extract from whose report is appended.

Gauge near Cullums Ripple, 471½ miles below Pittsburg.—In response to requests from steamboat owners, pilots, and others, a gauge has been erected on the Kentucky shore a short distance above Cullums Ripple, to indicate the clear headway under the channel span of lowest bridge crossing the Ohio at Cincinnati. The gauge is so located and constructed as to be easily read from passing steamers during the day, and also at night by the steamer throwing her search light so as to illuminate it. The gauge is made in five sections ranging up the bank, and indicates the clear headway under the lowest bridge from 45 feet up to 70 feet. The gauge has proved of much value to commerce. A detailed description is given in the appended report of Mr. R. R. Jones, assistant engineer.

Dredging at Flint Island, 683 miles below Pittsburg.—The steamboat men having complained, July 21 and 22, 1893, of suspended navigation at this island, with only 30 inches of water on the bar, and 5 feet

above and below, a dredging outfit was obtained and began dredging the bar on July 29, and continued until August 5, 1,200 cubic yards of material being removed, and a 5-foot channel opened through the bar.

Dredging at Chenaults Reach, 689 miles below Pittsburg.—Dredging was also reported as needed at this place. The plant at Flint Island, after having finished there, was accordingly removed to this place, and excavated 300 cubic yards of gravel and mud, a large quantity of drift-wood, and 14 logs from 1 to 2 feet in diameter, and 10 to 15 feet in length.

Dike and dam at French Island, 761 miles below Pittsburg.—A contract was made with William Kirk, dated June 20, 1893, approved June 30, 1893, work to be completed December 31, 1893, for the construction of two dikes and one dam. Work commenced July 19 and was continued until December, 1893, when it was suspended for the season. The following amounts of material were expended:

Material.	Dike No. 1.	Dike No. 2.	Dam.
Piles.....number..	112	117	120
Timber.....feet, B. M..	8,280	.....	1,920
Bolts.....pounds..	621	.....	162
Stone.....cubic yards..	1,093.5	1,234.4	4,583.2

On the recommendation of the engineer officer in charge, the contract was extended to November 30, 1894. Under the extension work has not yet been resumed.

To supplement the action of the dikes, and to remove a portion of an old dike built in 1832, which was much in the way, a dredging plant was hired in June, 1894, and at the close of the year had removed about 1,250 linear feet of the dike and two barge wrecks, thus materially improving the channel.

Dikes at Scuffletown, 767 miles below Pittsburg.—A contract was made with L. Cramer & Son, dated June 20, 1893, approved June 29, 1893, for construction of two dikes, work to be completed December 31, 1893. Work began in August and was continued until December, 1893, when it was suspended for the season. The following materials were expended:

Material.	Dike No. 1.	Dike No. 2.
Piles.....number..	94	212
Stone.....cubic yards..	1,199	1,531
Timber.....feet, B. M..	.....	6,960
Bolts.....pounds..	.....	478
Excavation.....cubic yards..	.....	143

The contractors, through failure to furnish proper plant, materials, and labor, have been very slow and inefficient, but it was deemed to the best interests of the United States to extend their contract to November 30, 1894, under supplementary agreement giving the United States power to enforce proper progress for future work. The contractors resumed work under the modification in May, 1894, and at the close

of the year the following additional material had been expended in the work:

Material.	Dike No. 1.	Dike No. 2.
Stone.....cubic yards..	609	535

The works are approximately one-third completed.

Dike at mouth of Tradewater River, 862 miles below Pittsburg.—A contract was made with William Kirk, dated June 20, approved June 30, 1893, for construction of one dike to be completed December 31, 1893. Work was commenced July 22, 1893, and was continued until December, 1893, when it was suspended for the season. The following materials were expended:

Piles	number..	368
Brush mats	square yards..	2,965.8
Stone	cubic yards..	6,854.6
Binding poles	linear feet..	2,100

On the recommendation of the engineer officer in charge, the contract was extended to November 30, 1894. At the close of the year work had not been resumed.

The construction of this dike involved the crossing of the low-water channel and forcing a new channel through the bar. When the dike had been extended 1,879 feet from the Indiana shore it was found necessary to suspend further extension until the channel should cut out farther toward the Kentucky shore.

Surveys made last fall showed that the dike was causing great scour on the bar and movement of the channel in the desired direction. A survey is now in progress to ascertain the condition of the channel and determine whether the dike should now be extended to the length contemplated in the plan, or remain as it is, to await further action of the current on the bar.

Dikes at Mound City, Ill., 959 miles below Pittsburg.—A contract was made with Frederick Hartweg, dated June 20, approved June 30, 1893, for construction of two dikes, to be completed December 31, 1893. Work was commenced in September, 1893, and continued until December, 1893, when it was suspended for the season. The following materials were expended:

Material.	Lower dike.	Upper dike.
Piles.....number..	258	
Brush mats.....square yards..	4,?89	
Binding poles.....linear feet..	3,120	
Stone.....cubic yards..	6,418.2	625.5

On recommendation of the engineer officer in charge, the contract was extended to November 30, 1894. At the close of the year work had not been resumed. These dikes have approximately reached the lengths designed, but the material has not yet been distributed as intended on account of the stage of the river being too high to permit proper handling. Dredging in the channel will be done during the present season, and it is hoped that the desired effect of the work, that is, the formation of a good channel along the front of Mound City, will be obtained by the end of the present season.

rations of United States dredges.—The dredging fleet, which had in winter quarters in the mouth of the Little Blue River, was to Pittsburg and necessary repairs began in March, 1893. The s were completed in June, and work of dredging commenced. g the calendar year, 1893, the fleet worked at the following places, ing the material shown:

	Material dredged.	Rocks.		Snags.		Piles.
		No.	Weight.	No.	Weight.	
	Cu. yds.		*Tons.*		*Tons.*	*No.*
land Dam	3,404.3					
swickley Creek Bar	16,268	2	1.8			
ton Bar				1	6.7	
ek Bar	10,591	20	37.8			
a Island Dike				1	1	70
Sun Upper Bar	29,152	1	1	15	43.8	
Sun Middle Bar	79,791					
der Bar	24,819					
River Bar	450					

rk for the season of 1893 was suspended in November, and the aid up for the winter in the mouth of the Kentucky River. In atter part of April, 1894, the plant was brought to Cincinnati, some minor repairs were made, and then sent to the Clusters ds, 52 miles below Pittsburg, where operations were resumed, ing in the removal of 35,394 cubic yards of gravel and bowlders, ome large rocks. The river having fallen too low for work at this , the plant was taken to Pittsburg, June 29, to commence work at house Ripple.

letailed report of operations for the calendar year 1893 is given r. E. J. Carpenter, assistant engineer, in immediate charge of the an extract from which is appended, and also an extract of his giving summary of work this season at Clusters Islands.

roachments.—Information has been received at various times that n parties were dumping material into the river or over its banks, lding structures which would prove obstructions to the waterway. tigations have been made and when necessary the matter has reported to the U. S. district attorney for his action.

bor lines.—The present Board of Engineers having under consid- n the harbor lines at Pittsburg, Wheeling, and Cincinnati have their report on the lines at Wheeling, which report and accom- ng maps have been approved by the honorable Secretary of War ie Chief of Engineers. The reports and maps for the other two are in process of preparation and it is hoped to complete them early day.

cial surveys of Ohio River.—Special surveys have been made at pha Bar, 196 miles below Pittsburg, at Madison Harbor, Indiana, iles below Pittsburg, and at French Island, 761 miles below urg, to determine the condition of the channels at those places. tial survey was also made at Eight Mile Bar, 458½ miles below urg, to ascertain the condition of the channel as affected by the likes built in 1892. There has been a decided improvement in the el at this place, boats having continued to pass during the entire l.

piers.—The winter having passed without the formation of dan- s ice in the river, there has been no necessity for river craft to rotection behind these piers.

STAGES OF THE OHIO RIVER DURING 1893–'94.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the Uppper, Middle, and Lower Ohio:

Gauge of Davis Island Dam, near Pittsburg, Pa.

[When the dam is up, low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

Year and month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1893.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
July	10	21	0	5.6	2
August	29	2	0	4.4	1.3
September	25	5	1	6.4	1.7
October	15	16	2	6.9	2
November	2	28	4	8	2.9
December	0	31	26	14.2	5.3
1894.					
January	0	31	27	10.2	5.1
February	0	28	26	14.5	5.4
March	0	31	31	13.8	6.5
April	0	30	28	12.1	5.8
May	0	31	20	21.8	4.1
June	0	30	12	9.8	3.2
Total	81	284	177		

Cincinnati gauge.

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

Year and month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1893.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
July	0	31	31	11.4	4.1
August	0	31	2	6	3.6
September	0	30	18	10.3	3.8
October	0	31	28	19.5	5
November	0	30	30	13.8	4.4
December	0	31	31	21.3	9.1
1894.					
January	0	31	31	21	15.4
February	0	28	28	35.6	17.2
March	0	31	31	27.5	17.8
April	0	30	30	25.3	14.2
May	0	31	31	32	9.4
June	0	30	30	20.6	7.5
Total	0	365	321		

Evansville gauge.

[The zero of this gauge is about at low-water line; readings of 2 feet correspond to about 4 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.]

Year and month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1893.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
July	0	31	17	9.7	4.5
August	10	21	0	4.9	1.9
September	7	23	2	6.2	1.6
October	0	31	12	11.7	3
November	0	30	23	9	5.1
December	0	31	31	16.6	6.8
1894.					
January	0	31	31	17.9	10.8
February	0	28	28	31.8	13.5
March	0	31	31	21.4	16.3
April	0	30	30	21.9	13.5
May	0	31	31	22.5	8.3
June	0	30	26	20.7	5.6
Total	17	348	262	.....	.....

OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low drawbridges on the Ohio River. The general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more than 40 feet, it is also provided that all bridges below the Cincinnati Suspension bridge shall have a draw for use in high water, unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls bridge at Louisville is exceptionally located, and no record of its operation is kept. Reports received from the Cincinnati Southern Railroad bridge at Cincinnati, and the Kentucky and Indiana bridge at Louisville, state that the draws were not opened for the passage of boats during the fiscal year.

STOPPAGE OF NAVIGATION BY ICE.

The winter of 1893–'94 being comparatively mild, no interruption to navigation was caused by ice.

LOSSES BY COLLISION WITH BRIDGES.

The following tables show the losses sustained by the commerce of the Ohio River by collision with the piers of bridges crossing the Ohio River:

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Steubenville bridge:				
Previously reported				$90,308.00
Dec. 17, 1893	T. Fawcett & Son	Mink, No. 2	1 boat of coal	2,000.00
Total				92,308.00
Bellaire bridge:				
Previously reported				135,156.00
Feb. 8, 1894	C. Jutte & Co	Onward	1 fuel boat of coal	500.00
Feb. 10, 1894	Lysle Coal Co	Josh Cook	1 boat and 1 flat of coal	2,000.00
Total				137,656.00

Losses by collision with bridges—Continued.

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Parkersburg bridge:				
Previously reported				$72,677.00
Dec. 20, 1893	W. W. O'Neil Coal Co.	W. W. O'Neil	1 boat of coal	2,000.00
Do	Advance Coal Co	do	2 flats of coal	1,000.00
Total				75,677.00
Louisville and Jeffersonville bridge:				
Dec. 21, 1893	Jno. A. Wood & Son	Jim Wood	1 boat of coal	1,800.00
Dec. 23, 1893	W. H. Brown Sons	Cruiser	2 model barges of coal	6,000.00
Total				7,800.00

Losses by collision with Ohio River bridges to June 30, 1894.

Beaver bridge	$56,040.00
Steubenville bridge	92,308.00
Wheeling and Martins Ferry bridge	9,800.00
Bellaire bridge	137,656.00
Parkersburg bridge	75,677.00
Point Pleasant bridge	9,600.00
Kenova bridge	18,700.00
Newport and Cincinnati Railroad bridge	44,107.00
Covington and Cincinnati Railroad bridge	43,300.00
Cincinnati Southern Railroad bridge	9,812.00
Louisville and Jeffersonville bridge	7,800.00
Ohio Falls bridge	80,350.00
Kentucky and Indiana bridge	27,767.00
Cairo bridge	23,496.65
Henderson bridge	20,520.00
Total	656,933.65

ESTIMATES.

In work of the character of that for the improvement of the Ohio River, it is impossible to determine in advance just where and how much work will be needed for making good navigation upon the entire length of the river, and therefore it is impossible to submit estimates for complete improvement. The work must be progressive and tentative, and owing to the varied interests and communities along nearly 1,000 miles of river, the locations of works must be at considerable distances apart, so that no one reach of river can be taken in hand, and improvement completed in advance of other parts of the river, unless large amounts of money are provided. The great and growing commerce of this river, its numerous cities, and the rapid increase of the already large population of the valley, should appeal in strong terms for adequate appropriations for such betterment of the navigation as it is certain can be obtained by well-known methods. The sum of $1,000,000 can be profitably used, and produce immediate results, in great improvement for the movement of the vast commerce of the river. Attention is particularly invited to the commercial statistics appended.

Money statement.

July 1, 1893, balance unexpended	$311,528.55	
Sale of property	650.00	
		$312,178.55
June 30, 1894, amount expended during fiscal year		124,585.08
July 1, 1894, balance unexpended		187,593.47
July 1, 1894, outstanding liabilities	17,117.22	
July 1, 1894, amount covered by uncompleted contracts	35,706.85	
		52,824.07
July 1, 1894, balance available		134,769.40

Amount that can be profitably expended in fiscal year ending June 30, 1896	1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals for furnishing towboat as tender to U. S. dredges Ohio and Oswego, received in response to advertisement dated May 7, 1894, and opened June 8, 1894, by Lieut. Col. Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Price per day.
1	Fulton Towboat Co	$43.00
2	Hulings Bros.*	37.59

* Recommended for acceptance.

Abstract of contracts.

Contractor.	Work of improvement.	Date of contract.	To expire.
Hulings Bros	Furnishing towboat for U. S. dredges	June 20, 1894	At close of season.

BOGSTOWN.

[Extract from report of Mr. William Martin.]

Work on the dike, which was suspended on account of objections made by navigators, was resumed in accordance with your letter of instructions, dated August 26, 1893, viz, to build Dike C to a height of 5 feet above low water, and Dike A to have its top 1 foot below low water. Work was resumed on Dike C September 13. One thousand seven hundred cubic yards of stone for this work was taken from the old dike and 485.5 cubic yards was received from Hulings Bros. A gap of 125 feet in the lower end of the training dike remains to be completed. Stone for this purpose was purchased, but on account of low water had to be unloaded in the river outside of the dike. Work placing the stone in the gap was commenced, but a rise in the river prevented much work being done. The finished surface of the training dike was completed both above and below the main stem; also the outer 240 feet of the main stem was paved with stone set on edge. All this part of the structure, by a recent inspection, is found to be in good condition, except two breaks about 5 feet long at a point in the main stem near the outer end; these can be easily repaired. That part of the main stem next the shore, 372 feet long, was built of rough riprap stone, placed to conform to the required section of the dike. The crest of this part of the dike has been reduced by floods from 1 to 1½ feet. At the upper end of the training dike a strong current exists; to prevent injurious scour, 116 large stones, containing 1 cubic yard each, were placed as a protection at that point. A covering of gravel 6 inches deep was put over the surface of the work, to fill the voids in the stone. No work has been done on Dike A. A survey of the site and vicinity of the dike is now making to cover the same area as the original survey made by Mr. Schenk.

REMOVAL OF ROCK BAR AT MOUTH OF LICKING RIVER.

[Extract from report of Mr. R. R. Jones.]

The entrance to the Licking River is obstructed by a large bar in the Ohio River extending along the Kentucky shore above and below the mouth, covering, in all, some 48 acres, and leaving a narrow but sufficiently deep channel on the Ohio side along the water front of Cincinnati. This bar has obstructed navigation for many years, but in 1884 even the shallow channel which the Licking held through it up to that time became filled up as a result of a freshet, and since 1884 navigation on the Licking has been completely cut off at low-water stages. This bar consists of limestone rock ledges more or less overlaid with loose rock, sand, and gravel.

The project for the improvement of the mouth of the Licking contemplated the cutting of a channel through the bar from a point within the Licking where a good depth of

water prevailed, to the navigable water in the Ohio, this improved channel to have a depth of 4 feet at extreme low water and a mean width of about 200 feet. This channel, it was estimated, would involve the removal of 19,878 cubic yards of rock. By the river and harbor act of August 5, 1886, an allotment of $18,750 was made for the prosecution of the work, and under contract dated July 15, 1887, 1,384.6 cubic yards of material were removed, resulting in a cut 65 feet wide and 135 feet long at the south end of proposed channel. This exhausted the allotment. By the river and harbor act of August 11, 1887, there was allotted the sum of $25,000, and the act of September 19, 1890, made an allotment of $20,000 for the further prosecution of the work. A contract dated July 12, 1889, provided for removal of rock under these allotments, but after a delay through two seasons it was abandoned by the contractor and the contract annulled. Under authority granted to perform the work by hired labor a plant was procured and work commenced July 6, 1891, which extended to November 15, 1891, and resulted in the removal of 2,235 cubic yards of material. Up to the beginning of the fiscal year July 1, 1893, there had been removed in all 3,619.6 cubic yards, at a total cost of $47,348.36.

The excavation was made along the west side of channel for a distance of about 475 feet, all the work being performed by open cut in cofferdam. This method having proved costly and subject to delay from sudden rises in the river, it was determined to carry on the work by means of submarine blasting and dredging.

A steam drilling scow was constructed and commenced work in the latter part of September, 1893. The hull of the scow is 125 feet long, 22 feet wide, with gunwales consisting of three sticks of 16 inches each, making a total of 4 feet depth. Three longitudinal and six transverse bulkheads serve to further strengthen the hull, and these as well as the gunwales are securely bolted together. Two spuds at each end of the boat hold it in position, and along one side of the deck a track extends for a length of 105 feet, carrying the two carriages from which the steam drills are suspended. A deck house 12 feet wide and 8 feet high extends for a length of 60 feet in the center of the scow as regards its length, but slightly to one side transversely in order to balance the weight of the drilling apparatus. The gunwales and bulkheads are of yellow pine; the bottom and deck timbers and planking of white oak; and deck house of white pine; the roof covered with tongued and grooved boarding overlaid with canvas. The scow is provided with one 40-horse-power steam boiler of the locomotive type, with both steam feed pump and injector, 2 pairs of 6 by 5 inch duplex steam engines for operating capstans and spuds, a large pressure pump for cleaning the drilled holes by means of a hose, and all necessary steam and water connections.

The drilling apparatus consists of two No. 5 Ingersoll-Sargeant steam drills, hung from crossheads sliding on guides attached to the vertical frames of the carriages, and balanced so as to be quickly adjusted. The center of drill is about 5 inches outside the line of the hull. The total length of a line which can be drilled in one position of the scow is 100 feet, the usual practice being to drill 26 holes 4 feet apart when the rock reef is continuous for that distance.

The drilling plant, in addition to the scow, consists of two small floats in connection with the steam drills, a small fuel flat, and two skiffs used in placing anchors, etc.

After a line of holes had been drilled they were cleaned out by means of a jet of water introduced from a hose, and were charged with dynamite. Insulated wires leading from the exploders were connected so as to form a circuit with a battery by means of which the entire line of holes was exploded, after the scow had been moved to a safe distance.

Owing to delay in the arrival of the timber required for the hull the scow was not completed ready for service until September 21, 1893. At this time the water was quite low and, although the scow drew but 15 inches of water, some preliminary dredging was required to bring it out of the Licking, on the banks of which it was built. A steam dredge used for unloading coal barges at landings was the only thing then available for dredging, and this was procured and put to work September 1, removing the loose rock and gravel, and thus making a channel 30 feet wide and 300 feet long through the worst portion of the bar, with a depth of from 2½ to 3½ feet at the stage of water then prevailing. This temporary channel was available for the operations of the drilling scow until the water rose sufficiently to enable it to lay over the higher portions of the bar, and was also used to float the loaded barges which conveyed the dredged material to a point where their deposition did not interfere with navigation. The work of blasting was continued from September 21, 1893, except for a few days' interruption from high water in October, until November 21, 1893, and the dredging of blasted rock and loose overlying rock and gravel from September 1 to November 21, when funds becoming exhausted work was stopped and the scow taken into winter quarters.

The project for the season of 1893 contemplated the cutting of a channel 300 feet

in length and from 60 to 100 feet in width, through the worst portion of the bar, so as to give 4 feet at low water.

The blasting accomplished was as follows:

For the first 100 feet in length a channel was blasted 58 feet in width; for the second 100 feet the width was 65 feet; and for the third 100 feet the width was 27 feet. At this point the work was of necessity suspended from lack of funds. The above described cut was made along the west side of projected channel. In addition some blasting was done a little east of the center of proposed channel on the first range of 100 feet. So far as could be noted the required depth of water was obtained by subsequent dredging. Owing, however, to the contracted space it was not possible to remove all the blasted rock before the suspension of work for the season, as the drilling scow interfered with the operations of the dredge on blasted rock so that it became frequently necessary to move the dredge over to the center or east side of proposed channel, where it removed quantities of the loose rock overlying the solid ledge. A considerable quantity of the blasted rock, therefore, still lies in the channel. The removal of the loose rock and gravel which was accomplished will not only materially expedite the progress of the drilling, but has already improved the entrance to the Licking River.

A change of dredges was made on November 1, which resulted in a greatly increased amount of excavation. The dredges used on the work were without spuds (no others being obtainable), and had to be held in position by means of lines and anchors. This often caused some delay, due to the necessity for removing or slacking off the lines when boats passed into the Licking River. The loose material overlying the solid ledges was sometimes as much as 3 feet in thickness, and was composed of a little sand, gravel, and loose rock. The latter varied in size from a few inches square to 5 and 6 feet square with a thickness of a foot or more. The steam drills readily penetrated this mixture of loose stuff, but great difficulty was at first experienced in charging the holes after they were drilled, as loose rock and gravel dropped into the holes as soon as the drills were removed. This difficulty was overcome by the use of iron pipes surrounding the drills, these being forced down so as to form a sort of casing to the hole as fast as drilled. As each hole was drilled it was charged with the requisite number of dynamite cartridges made up into a compact package, held together with heavy muslin. This latter precaution was rendered necessary from the fact that cavities were often encountered large enough to permit the several cartridges to become separated from each other unless fastened together. The package of dynamite cartridges was introduced into the hole through a copper pipe, which was withdrawn as soon as they were properly placed. After the copper pipe had been withdrawn, and not before, the casing pipe was removed, thus allowing the loose gravel and rock to fall over and into the hole above the dynamite.

During the season's work 892.2 cubic yards of solid rock were blasted and 4,215.5 cubic yards of material dredged, the dredged material, as has been before stated, consisting of blasted rock and loose overlying rock and gravel. Of the total quantity dredged, 3,215.5 cubic yards were removed on barges to a point inside Cullums Ripple, and used in the construction of a cross dike.

A summary of the total material removed from the bar at mouth of Licking River is as follows:

Season 1887, by contract in cofferdam	1,384.6
Season 1891, by hired labor in cofferdam	2,235
	3,619.6
Season 1893, by hired labor, blasting and dredging	4,215.5
	7,835.1

The lower portion of the Licking River, extending from its mouth to at least Milldale, Ky., is used for the extensive distribution and storage of coal received on barges from the Ohio River.

Among others using the river in this way are:

The Covington Rolling Mill Company, of Covington.
Swift Iron and Steel Company, of Newport.
"Old '76" Distilling Company, of Newport.
Latonia Distillery.
Covington Gas Works.
Milldale Distilling Company.
Milldale Coal Elevator.
Livezy's sawmill.
Campbell Creek Coal Company.
Licking Coal and Towboat Company.

The above-named parties represent a large amount of invested capital, and contribute not only to the prosperity of the cities of Covington and Newport, Ky., but, in the case of the distilling companies, pay a large amount of the internal taxes direct to the General Government. Access to the Licking is now precarious, and at times cut off entirely. It may also be noted that all projects for the improvement of the Upper Licking will be of little or no value until the channel already projected has been cut through the bar at its mouth. The project could be much more economically accomplished by the concentration of a large amount of work in one season, rather than by extending the same over several years. From what can be learned of the Licking, it is believed that once a continuous channel is cut through the bar, the freshets would keep the same scoured out.

An estimate of the amount required to complete the project, and the amount which can be profitably expended during the fiscal year ending June 30, 1896, is as follows:

Amount estimated to complete channel by blasting and dredging, from July 1, 1893	$95,037.00
Expended during fiscal year ending June 30, 1894, including cost of drilling and blasting plant	16,378.28
Amount estimated to complete project	78,658.72
Amount which can be profitably expended during the fiscal year ending June 30, 1896	35,000.00

WATER GAUGE AT CULLUMS RIPPLE, 471¼ MILES BELOW PITTSBURG.

[Extract from report of Mr. R. R. Jones.]

I have the honor to submit the following report on the establishment of a gauge on the Kentucky bank of the Ohio River, a short distance above the dike at Cullums Ripple.

In the spring of 1893 the steamboat owners and pilots petitioned for the establishment of a gauge to be located near Cullums Ripple, which should indicate to boats passing upstream the clear space between the water surface and the lowest portion of the lowest bridge at Cincinnati. By locating such gauge at or near Cullums Ripple timely notice would be given to boats and preparations commenced for lowering the chimneys, when the stage of river rendered it necessary.

By your direction I located temporary gauges, from which daily readings were taken during the spring and summer of 1893, and the data thus obtained formed the basis for determining the permanent gauge. The owner of the land on which it had been determined to locate the permanent gauge demanded a large yearly rental for the privilege of placing on his property the posts constituting the proposed gauge, and after much time had been lost a new location was settled on.

The gauge, as now permanently constructed, is located on the premises of Mr. James S. Anderson, on the Kentucky shore, a short distance above the dike. Mr. Anderson gave permission for the erection of the gauge, and was most kind and obliging in facilitating the progress of the work. The gauge consists of 5 posts, each post marking 5 feet in height, and so arranged that the total combined reading is 25 feet. The lowest post has a board 12 inches wide and 3 feet long attached near the bottom. This board is marked 70, and indicates that when the water surface is even with the bottom of the board there is 70 feet of space between the water and lowest portion of channel span of the Newport and Cincinnati Railway bridge. The post extends 5 feet above the bottom of the board, and is marked off in alternate blocks of black and white, each block measuring a rise of 1 foot. The second post from the lower end of series has a board attached near the bottom, the bottom of the board being level with the top of the lower post, and marking 65 feet clear space under the bridge aforementioned.

The board on third post marks 60 feet and the post carries the reading up 5 feet.

The board on fourth post marks 55 feet and the post carries the reading up 5 feet.

The fifth post has two boards attached, the bottom of the lower board marking 50, and the bottom of the upper board marking 45 feet.

The above readings are for the Newport and Cincinnati Railway bridge, this being lowest bridge crossing the Ohio River at Cincinnati. Boats which do not run above Cincinnati and do not pass under this bridge, may count on having not less than 4 feet additional of clear space under the channel spans of any of the other bridges. That is, with the gauge indicating 70 feet under Newport and Cincinnati bridge (Pennsylvania Railroad and Louisville and Nashville Railroad) there would be 74 feet under any other bridge.

65 feet under Newport and Cincinnati bridge = 69 feet under any other bridge.
60 feet under Newport and Cincinnati bridge = 64 feet under any other bridge.
55 feet under Newport and Cincinnati bridge = 59 feet under any other bridge.
50 feet under Newport and Cincinnati bridge = 54 feet under any other bridge.
45 feet under Newport and Cincinnati bridge = 49 feet under ar other bridge.

The posts are 10 by 10 inches, white oak, placed about 4½ feet in the ground, with ro sets of double crosspieces, 3 by 8 inches, securely spiked at the bottom, these osspieces being 4 feet long and extending in both directions. The boards on hich the numbers are painted are let in flush with the river side of post, and each ard securely fastened with 4 lag screws.

DREDGING AT FLINT ISLAND AND CHENAULT REACH.

[Extract from report of Mr. R. R. Jones.]

During the latter part of July complaints were made by the steamboat men that vigation was practically suspended at Flint Island by reason of the bar opposite e dike, through which there was a channel of but 30 inches.
By your direction I proceeded to Louisville, Ky., July 26, procured a dredging tfit and towboat and started for Flint Island, arriving at that point on the morn- g of July 29.

FLINT ISLAND.

After a careful examination of the location the best channel was marked by a line bouys, and the dredging commenced at a point where it would assist and direct e natural scour from the current. The work of dredging was completed August 1,200 cubic yards of gravel and sand having been removed by the dredge, and the annel deepened so that there was not less than 5 feet of water throughout, at a age corresponding to 4½ feet on Evansville gauge.
Soundings were taken at Flint Island Bar and vicinity during the progress of the ork. At points where borings were made no rock was encountered at 8 feet below rface of water. The dredging was restricted to the left-hand side of channel at e lower end of the crossing. On the right-hand side the material was scoured vay by the current.

CHENAULT REACH.

The dredging outfit was taken to Chenault Reach, some 6 miles below Flint Island, ugust 6, where it was employed until August 10 in cutting off the point of a bar hich projected into channel from the Indiana shore. Three hundred cubic yards of nd and gravel and 14 large logs were removed. The dredging outfit was started p the river August 10, and reached Louisville August 13.

MBANKMENT AT SHAWNEETOWN, ILL., 848 MILES BELOW PITTSBURG.—CONDITION, FURTHER WORK PROPOSED, AND ESTIMATE OF COST.

The following was embodied in a letter to the Chief of Engineers, S. Army, February 21, 1894:

The work at Shawneetown consists of a levee surrounding Shawneetown on all les, except at the rear, which is high ground. There has been expended upon this ork about $308,000, of which about $231,000 was furnished by the city, $40,000 om State taxes, and about $37,000 expended by the United States. The amount pended by the United States under the immediate direction of this office was ecifically allotted in the river and harbor acts of 1888, $15,000; 1890, $15,000; 1892, ,000. These amounts were allotted without recommendation from the engineer icer in charge of the district, and seemingly without any definite plan and esti- te of cost for a complete work.
The action of this office has been to submit and execute projects for the expendi- re of the amounts allotted by Congress, and these projects have been in accord- ce with the desires of the citizens. The work has not been considered by this ice as part of the necessary work for the improvement of the Ohio River, and erefore in annual reports no further work beyond that provided for by appropria- n already made was proposed or estimated for. The work that has been done by e United States appears to have met the full approbation of the city authorities d citizens of Shawneetown, and it is known that they desire further work done the direction of strengthening and protecting the levee.
I am able to present an estimate of the cost of this desired work, which I do in mpliance with directions. The estimate for additional work is $12,000, for details which I would refer to the inclosed copy of letter of Mr. H. Devereux, who made survey of the levee and acted as inspector of contract work. For a brief history the origin, progress, and present condition of the work I would refer to the closed copy of a report of Lieut. W. C. Langfitt, Corps of Engineers.

ESTIMATE OF COST.

[Extract from report of Mr. H. Devereux.]

I have the honor of submitting the following estimate of material required and approximate cost of improving the embankment at Shawneetown, Ill.:

(1) By strengthening the north wing of the present embankment on the outside or water slope for a total distance of 2,895 feet, between the McLeansboro road and the hills, uniformly with the partial improvement made in 1893, by adding material in such manner as to place the crest or upper line of the slope in the plane of the top of the present embankment, and at a distance of 8 feet from the middle plane thereof. The slopes to be flattened to an uniform slope of one vertical on two horizontal.

(2) By protecting from washing and scouring, due to the action of heavy winds and a swift current at high stages of the river, that portion of the embankment lying between Church street and McLeansboro road, by covering the exterior slope, for a distance of 12 feet from the crest, with flat stones, not less than 6 inches in thickness, laid in juxtaposition, the next width of 12 feet with 12 inches, and the remainder of the slope to the bottom with 18 inches of riprap stone—a linear distance of 1,750 feet.

(3) By repairing washes and slips, throughout the balance of the embankment, by adding earth.

(4) By repairing present paved and riprap protection on the front and south wing of the embankment, by refilling cavities, adding stone, replacing stone and repairing pavement.

The quantities of material required and an approximate cost are as follows, viz:

Earth, north wing, 15,000 cubic yards, at 30 cents	$4,500
Riprap stone, north wing, 2,550 cubic yards, at $2	5,100
Refilling washes (earth), 500 cubic yards, at 50 cents	250
Repairing old paving, 1,000 square yards, at 50 cents	500
Superintendence	1,000
Total	11,350

To this should be added office expense, advertising, etc.

REPORT OF LIEUT. WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, February 20, 1894.

COLONEL: In compliance with your verbal instructions, I have the honor to submit the following report relative to the levee work done by the United States at Shawneetown, Ill.:

The earliest mention which I can find in the records of this office of the harbor and levee at Shawneetown is a report by the late Lieut. Col. William E. Merrill, Corps of Engineers, to the Chief of Engineers, in compliance with instructions dated April 1, 1884, in second indorsement on letter of Hon. R. W. Townshend, M. C., to the Secretary of War, said letter inclosing a petition for *the improvement of the harbor at Shawneetown, Ill.*, and requesting an estimate of the cost. In this report Col. Merrill says: "There is a troublesome shifting bar in the bed of the Ohio, just above Shawneetown, which will have to be taken in hand at some future date, but the harbor improvement that is sought in the accompanying papers is the creation of a *high-water* port, so that steamboats can land and transfers can be made during such floods as visited the Ohio Valley in 1883 and 1884. * * *" He further states that prior to 1883 the people of Shawneetown had built levees for their protection, inclosing the business portion of the town and extending back to the hills. Their total length was 3¾ miles. The flood of 1883 overtopped them by from 2 to 4 feet and damaged them considerably. They were not repaired and the flood of 1884 again overtopped them, inundating the town so that the highest point of the inclosed land was 11¼ feet under water and the lowest 17 feet. He estimates that it would cost $72,550 to repair the levees and raise them to height of 2 feet above the flood level of 1884.

In the river and harbor act approved July 5, 1884, "Shawneetown Harbor and Levee" are mentioned among the list of places at which the Secretary of War should "cause examinations or surveys, or both, and estimates of cost of improvement proper to be made." Under this act Lieut. Col. Merrill was charged with making the preliminary examination of Shawneetown Harbor and Levee and reported as follows:

"[Second indorsement.]

Respectfully returned to the Chief of Engineers.
According to my understanding of the case the people of Shawneetown wish ection from such floods as have recently overwhelmed them, and the 'harbor' ch they desire is such an elevation of the 'levee' as will permit boats to land ng floods. In all other cases on the Ohio River when the question of harbor has involved the desire has been to secure a greater depth *in low water*. What is ted, therefore, at Shawneetown is simply a levee against floods. If it is the ntion of the Government to build levees around towns subject to inundation, this locality is decidedly 'worthy of improvement.' If, however, the question is solely on the wants of commerce of the Ohio River, I am under the necessity tating that the interests of commerce would not be affected by the construction levee around Shawneetown, and, therefore, that from that point of view the or is not 'worthy of improvement.'
A high levee along the Shawneetown front would undoubtedly enable boats to during great floods, but at such times the only business done on the Ohio River ie transport of supplies to inundated towns, a business which can hardly be ed as commerce.
No further examination or survey is necessary."
othing further was done until after the river and harbor act of 1888, which act tained the following item: "Improving the Ohio River; Continuing improve- t, three hundred and eighty thousand dollars; * * * also out of said Ohio ar appropriation the sum of fifteen thousand dollars may be expended in the truction, or aiding in the construction, of such an embankment at Shawneetown, ois, as will confine the waters of the river, in great floods, to the general course s channel, and protect the harbor." * * *
a preliminary project submitted to the Chief of Engineers, dated August 25, , Col. Merrill took the view that the expenditure of the above allotment was rotionary with the Secretary of War, and recommended that it be not made, as xpenditure would have no effect in improving navigation. It was held, how- , by indorsements on this preliminary project by the Secretary of War and by Engineer Department that the expenditure for the purpose named was obliga- . In his final project for the expenditure for this work, dated January 3, 1889, Merrill says: "I find on investigation that much work has been done since the of the above report (May 17, 1884), and that the levee is now completed as to ht; the town authorities, however, desire the strengthening of the cross section arious points, and the revetting with stone of certain corners exposed to wash. levee is owned by the town." * * *
ntracts were accordingly made for these purposes, and were completed in the l year 1889–'90. By the expenditure of the money the levee was paved, strength- l, and raised where most necessary, so far as the funds would permit. No recom- dation was made for further appropriation, and in response to letter of inquiry hief of Engineers, dated March 14, 1890, Col. Merrill states, under date of March 890, that "the allotment of $15,000 made by the river and harbor act of August, 888, for the Shawneetown embankment is more than sufficient to complete all the k on this levee that was requested by the authorities of that city." The citizens, ever, desired further work, and in response to their requests Col. Merrill was ructed to submit a report on the needs of the embankment. In this report, dated il 29, 1890, Col. Merrill says that on account of the exposed position of the city in water, and to some little damage done by the recent flood, it would require a imum of $10,000 to make the levee reasonably safe, and that up to $20,000 could xpended without waste in repairing, strengthening, and raising the levee. He her states that Shawneetown is the only landing at high water for many miles g this portion of the river, and that during certain recent floods and storms ral boats took refuge there. He further showed that the city had spent, omitting e $40,000 received from State taxes, over $231,000 on the embankment, thus austing their private resources before appealing to the Government.
he river and harbor act, approved September 19, 1890, contained the following: proving the Ohio River: Continuing improvement, three hundred thousand dol- , of which sum * * *; and fifteen thousand dollars may be expended in com- ing the embankment at Shawneetown, already partly constructed for the preser- on of the harbor at that place." * * * Before submitting a project for the enditure of this allotment, Col. Merrill obtained a statement of the wishes of town authorities in the matter, and his project was formulated, so far as practi- e, in conformity thereto. Contracts for carrying it out were made, and the work emplated was completed April 5, 1892, leaving a balance of $3,217.19 on hand for her work.
ie river and harbor act of July 13, 1892, contained the following item: "Improv- Ohio River: Continuing improvement, three hundred and sixty thousand dollars,

of which sum $——— may be expended * * *; and seven thousand dollars in completing the work at Shawneetown, Illinois."

Lieut. Col. Amos Stickney having assumed charge of this district, a project for the expenditure of the above allotment and previous balance was submitted by him to the Chief of Engineers, under date of September 12, 1892. Contemplating the application of the money available to small repairs on the riprap protection of the front levee, strengthening some weak points in the south levee, and flattening the slopes of the north and south levees, to increase their stability, Col. Stickney says: "This is considered the most important work to which the money can be applied, and is in accordance with the recommendations of those citizens of Shawneetown who have been most active in having the levee built." The work was carried out on these lines and was completed June 1, 1893.

At that date the condition of the work was as follows: All the weak points were strengthened so far as practicable and necessary; the paving was all repaired and was in good condition. It extends over the east half of south levee, all of the front levee and around the northeast corner to Market street. The whole work seems amply strong for its purpose. The Ohio and Mississippi Railway is under contract with the city of Shawneetown to maintain in good condition "that portion of the north levee between Market street and the McLeansboro road."

No point of the embankment is below the level of high water of 1884, and its average height is 18 inches above that level. The average width on top is about 16 feet, and the side slopes average about 1 on 1¼, some places being a little flatter and others steeper, but probably none steeper than 1 on 1¼.

In a letter to this office, under date of June 9, 1893, Messrs. Charles Carroll and Carl Roedel, acting for and at the request of the municipal authorities, express their entire satisfaction with the plan and method of execution of the work recently done, and state that "we believe that these levees, when completed according to the plan now adopted, will accomplish, in the most substantial manner, the purposes expected by the Government and our people."

Also, on same date, Mr. Thomas S. Ridgway, in a letter to this office, expresses the opinion that the recent work was well done, and says: "We wish the appropriation had been very much larger, so he (the contractor at the time) could have continued the work which is necessary to complete and strengthen the levee." In neither letter do the writers state what further work they consider necessary, but I am informed that what is now desired more particularly is paving of that portion of the north levee, which, as stated above, the Ohio and Mississippi Railway is under contract with the city to maintain.

In conclusion, it will be noticed that in no case has there been any recommendation for an appropriation for this work, and, in fact, at the beginning, such appropriation was reported upon adversely by the late Lieut. Col. Merrill as not in the interests of navigation. The appropriations have all been made at the instance of the people of Shawneetown themselves. Further, all appropriations have been spent, so far as practicable, in accordance with the wishes of the people of that city and to their satisfaction. The population of Shawneetown, as given by the census of 1890, is 1,875.

The total expenditure by the General Government has been $37,000.

WM. C. LANGFITT,
First Lieut., Corps of Engineers.

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.

WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1893.

[Extract from the report of Mr. E. J. Carpenter.]

The dredges and the towboat *John C. Fisher*, which had served as tender in 1892, remained in winter quarters in the mouth of Little Blue River until after the ice in the Ohio broke up, when they were moved to Pittsburg to be ready for the repairs necessary to put them in order for work.

The annual repairs were begun on March 15, but owing to interruption from stormy weather and to difficulty in getting necessary material from the mills, were not completed until June 5.

The repairs were more extensive than usual on account of the damage to machinery, and particularly to the cranes, dippers, and spuds, which resulted from the pudding stone excavation at Brooklyn Harbor in the previous year. They included also a new boiler for the dredge *Oswego*, with the expense of setting it up, and a new hull for the steam launch.

On completion of the repairs the dredges were employed in the neighborhood of Pittsburg until the approach of the low-water season compelled them to move down the river.

Davis Island Dam, Pennsylvania, 4.5 miles below Pittsburg.—The dredges removed a bar of hard gravel and bowlders which, during the lower stages of river, interfered with the approach to the lock from below.

Excavation made June 2 to 9, gravel and bowlders..... cubic yards.. 3,404.3

Little Sewickley Creek Bar, 13.4 miles below Pittsburg.—This bar was dredged off with the result of materially straightening the channel, besides widening it 90 feet.

Excavation made June 9 to 24:

Gravel and bowlders	cubic yards..	16,268
Rocks removed, 2	tons..	1.8

Burlington Bar, 86.5 miles below Pittsburg.—While on the way down the river the dredges removed at this place June 27,

1 snag ..... tons.. 6.7

Mill Creek Bar, above New Matamoras, Ohio, 140.5 miles below Pittsburg.—The channel at this point was widened 140 feet by dredging off the creek bar, which had been built out into the river by a flood out of Mill Creek a couple of years previously, and had caused much delay to packets and to towboats.

Many large rocks were found in the bar and removed from the channel; but, as is customary, no record was kept of any except those too large to pass through the dredge dippers. The result of the work was to greatly improve the channel.

Excavation made June 28 to July 10:

Gravel and loose rocks	cubic yards..	10,591
Large rocks removed, 20	tons..	37.8

Marietta Island Dike, 171 miles below Pittsburg.—While traveling down the river the dredges stopped at Marietta and removed from the channel, below the wharf, July 11,

1 snag ..... ton.. 1

They also removed at the old dike July 11, 70 piles.

Rising Sun Bar, 501.5 miles below Pittsburg.—The object of the dredging at this point was to widen and straighten the channel opposite to and below the upper dike by removing part of the large bar on the left of the channel.

The upper end of this bar is cemented gravel, very little softer than the pudding stone found at Brooklyn, Ill., and this material proved very destructive to the dredge machinery.

The lower part of the bar consists of much lighter gravel, which was readily excavated, but at several points a large number of logs were found buried in the bar, causing the loss of much time for their removal.

The logs reported are only a small portion of those dug out, most of them being either carried away by the swift current or broken up by the dippers and removed in the scows with the gravel.

The dredging resulted in widening the channel to about 350 feet, and reduced the dangerous current at the lower end of the dike at least one-half.

A large amount of the dredged material was dumped behind the dike for the purpose of stopping the draft of water from the channel to the Indiana shore and to destroy the eddy below the dike.

Most of the material removed from the upper bar was dumped on the Kentucky shore to stop the waste of water behind the lower bar, but a considerable amount was dumped close to the new dike to stop the scour and consequent undermining of that structure.

The dredging already done will prevent any further loss of time by the packets at this place during the low-water season, but it will be necessary to remove more of both bars to finish the improvement.

Excavation made:

Upper Bar, hard gravel (part cemented), July 18 to October 16, cubic yards		29,152
Middle Bar, hard gravel, July 26 to November 24	cubic yards..	79,791
Total	do....	108,943
Logs removed, 15	tons..	43.8
Rocks removed, 1	do....	1

Gunpowder Bar, 509.6 miles below Pittsburg.—Work at Rising Sun was interrupted to cut a channel through Gunpowder Bar, where the packets have had serious loss of time for several years past during the low-water season.

The obstructions to navigation at this place consist of a hard gravel bar below the mouth of Gunpowder Creek, and a sand bar farther down, both of which extend clear across the river. As the river recedes at the beginning of the low-water season boats first have difficulty only at the sand bar, which acts as a dam and keeps sufficient depth of water on the gravel bar. The current, however, gradually cuts away the sand as the stage becomes lower, so that the water drains off above it, with the result that the rough gravel bar becomes a serious obstruction.

It was proposed to make three cuts through the gravel bar, but as the river fell so rapidly as to seriously interfere with the work by reducing the carrying capacity of the scows, and at the same time made necessary a long tow to the dumping ground, the number of cuts was reduced to two, making a low water channel about 65 feet wide for a distance of about 1,525 feet.

When the water on the sand bar became so shallow that packets could no longer get across, the Cincinnati and Louisville boats turned back from this place, after exchanging passengers and freight by transferring them across the bar on flats towed by small boats. As it finally became almost impossible to get even the lighters across, a channel about 1,100 feet long was made through the sand bar by driving water against it with the wheel of the dredge tender, a dredge being used to hold the towboat in position.

Excavation made:

August 4 to September 1, hard gravel	cubic yards..	16,754
August 25 to 31, light sand	do....	8,065

Licking River Bar, 466.3 miles below Pittsburg.—The dredge *Ohio* was brought from Rising Sun, and removed a spoil bank left from operations on the rock bar at the mouth of Licking River.

Excavation made November 25, loose rock ..... cubic yards.. 450

Upon completion of the work at Licking River Bar the dredges went to the mouth of Kentucky River, where they were laid up for the winter.

Ohio River dredging statement for 1898.

DREDGES IN COMMISSION.

TIME.

Time at work.	Days.	Time lost.	Days.
Dredging gravel and bowlders	61.6	Traveling	12.2
Dredging cemented gravel	23.8	Accidents	22
Dredging sand	3	High and low water	7.8
Dredging loose rock	.7	Fog	2.2
Removing rocks	2	Sundays and holidays	28
Removing logs and snags	3		
Removing piles	.7		80.2
	94.8		

Total in commission, 175 days.

WORK.

	Per day of work.	During season.
	Cu. yds.	Cu. yds.
Gravel and bowlders excavated	2,058.6	128,808.3
Cemented gravel excavated	1,224.9	29,152
Sand excavated	2,688.3	8,065
Loose rock excavated	642.9	450
Total excavation for the season		164,475.3

	Number.	Tons.
Rocks removed	23	40.6
Logs and snags removed	17	51.5
Piles removed	70	

Ohio River dredging statement for 1893—Continued.

COST.

	Per day in commission.	Per day of work.	For the season.
Equipment	$5.79	$10.69	$1,013.68
Towing and fuel	36.93	68.18	6,463.51
Repairs	8.56	15.80	1,497.39
Salaries	44.88	82.84	7,853.47
Total cost	96.16	177.51	16,828.05

DREDGES OUT OF COMMISSION.

TIME.

	Days.
In ordinary	107
Annual repairs	83
Total	

COST.

Salaries in ordinary	$1,344.06	
Towing, fuel, and other expenses	1,530.82	
Total in ordinary		$2,874.88
Salaries during annual repairs	5,573.85	
Annual repairs (shop bills, materials, etc.)	4,625.30	
Total cost of repairs		10,199.15
Total out of commission		13,074.03
Cost per day in ordinary (including superintendent's pay)		17.74

COST OF WORK, INCLUDING ALL EXPENDITURES, IN 1893.

Dredging gravel and bowlders	$19,745.47
Dredging cemented gravel	7,507.06
Dredging sand	946.27
Dredging loose rock	220.80
Removing rocks	504.67
Removing logs, snags, and piles	977.81
Total expenditures in 1893	29,902.08

COST PER UNIT.

Per cubic yard of gravel and bowlders excavated	$0.156
Per cubic yard cemented gravel excavated	.257
Per cubic yard sand excavated	.117
Per cubic yard loose rock excavated	.490
Per day in commission	170.87
Per day of work	315.422

The "day of work" is for ten hours' actual operation of the 2 dredges, with 4 dump scows, and 1 towboat for tender, after taking out every hour lost by accident or otherwise.

The towboat *John C. Fisher*, chartered as dredge tender, was paid $36.50 per day, this amount covering the cost of the boat with outfit, crew, and fuel for the towboat and dredges, except that all cost of coal in excess of 5 cents per bushel was repaid by the Government.

The "total expenditure" includes all outlay in 1893 except the following:

The cost of repairs paid for from the Brooklyn Harbor allotment has been left out, it having been charged to that work in the report for last year. The cost of the new dump scow has not been included, as it is not properly chargeable to one year's dredging; nor have bills for purchase of photographic material, transit instrument, and typewriter.

Location and description of work.

Place.	From Pittsburg.	Date.	Days of work.	Kind of work.	Logs and snags.		Rocks.		Piles.
	Miles.	1893.			*No.*	*Tons.*	*No.*	*Tons.*	*No.*
Davis Island Dam	4.5	June	3.6	Dredging gravel and bowlders.					
Little Sewickley Creek Bar.	13.4	June	11.8	....do					
Do	13.4	June	.2	Removing rocks			2	1.8	
Burlington Bar	86.5	June	.1	Removing snag	1	0.7			
Mill Creek Bar	140.5	June–July	6.1	Dredging gravel and bowlders.					
Do	140.5	June–July	1.3	Removing rocks			20	37.8	
Marietta Island Dike.	171	July	.8	Removing snag; pulling piles.	1	1			73
Rising Sun Upper Bar.	501.5	July–Oct	23.8	Dredging cemented gravel.					
Do	501.5	July–Nov	2.3	Removing rocks and snags.	15	43.8	1	1	
Rising Sun Middle Bar.	502	July–Nov	29.8	Dredging gravel					
Gunpowder Bar	509.6	Aug.–Sept	11.3	Dredging gravel and bowlders.					
Do	510.2	Aug.–Sept	3	Excavating sand					
Licking River Bar.	466.3	Nov	.7	Dredging loose rock					
Total			94.8		17	51.5	23	40.6	73

Place.	Excavation.				Expenditures.				Total for 1893.
	Loose rock and cemented gravel.	Gravel and bowlders, and sand.	Per day of work.	Cost per cubic yard.	Removing logs, piles, and snags.	Removing rocks.	Dredging loose rock and cemented gravel.	Dredging gravel and bowlders and sand.	
	Cu. yds.	*Cu. yds.*	*Cu. yds.*						
Davis Island Dam		3,404.3	945.7	$0.334				$1,135.52	$1,135.52
Little Sewickley Creek Bar		16,268	1,378.6	.229				3,721.99	3,721.99
Do						$63.08			63.08
Burlington Bar					$31.54				31.54
Mill Creek Bar		10,591	1,736.2	.182				1,924.08	1,924.08
Do						410.05			410.05
Marietta Island Dike					252.34				252.34
Rising Sun Upper Bar	29,152		1,224.8	.258			$7,507.06		7,507.06
Do					693.93	31.54			725.47
Rising Sun Middle Bar		79,791	2,677.6	.118				9,399.60	9,399.60
Gunpowder Bar		16,754	1,482.7	.213				3,564.28	3,564.28
Do		8,065	2,688.3	.117				946.27	946.27
Licking River Bar	450		642.9	.490			220.80		220.80
Total	29,602	134,873.3			977.81	504.67	7,727.86	20,691.74	29,902.08

DREDGING AT CLUSTERS ISLANDS.

[Extract from report of Mr. E. J. Carpenter.]

Owing to the necessity of dredging at the Clusters, a point where it is impossible for the boats to work during the low-water season, it was decided to omit or postpone the thorough repairs usually made before beginning each season's work, and to do only the refitting absolutely necessary to prepare the fleet for service.

The dredges were taken from their winter quarters in the Kentucky River to Cincinnati on April 26, and after building a new dipper pole and spuds, calking scows, and making such minor repairs as were possible at the same time, they left for the Clusters on May 8, arriving and beginning work on the 14th.

The dredging at this point is for the purpose of removing a gravel bar too hard to be affected by scour from the dikes now under construction.

The dredges were employed continuously after their arrival there, except during one week, when they were stopped by high water, and have made a marked improvement in the channel, which has been widened about 120 feet at the point where the

atest loss to coal tows has occurred, and to a greater extent immediately above below this point.
he length of bar dredged over is about 2,600 feet.
he low stage of river during the past week necessitated a temporary stoppage of rations on the upper half of the bar, but the work is in such condition that ther week at a favorable stage will suffice to increase the channel width 60 feet e at the dangerous point, although it will require about two months to finish the lging contemplated.

avation made, May 14 to June 29:

ard gravel and bowlders	cubic yards..	35,394
ocks removed, 4	tons..	15.6

n the 29th the river, already quite low, began to fall rapidly, and as the dredging his place could not be continued during the low-water season, and as the dippers poles were not in condition to proceed with work of this character, the fleet left Pittsburg, where, after necessary repairs, the boats could be employed in the bor pool, if the stage of river should not permit their return to the Clusters.
he dredges arrived at Pittsburg on the 30th.

SURVEY AT MUSTAPHA ISLAND.

[Extract from report of Mr. C. Schenk.]

he survey was begun at the lower end of the survey of Newberry Bar made in rember, 1884, being connected therewith and carried downstream about 2 miles a point about one-half mile below the foot of Mustapha Island.
nly one of the reference points, established on the survey of Newberry Bar could found, the remainder having been disturbed in constructing the Ohio River Raild. Connection between the two surveys would have been impossible or unsatistory if the Newberry survey had not been referred to the true meridian.
he survey of Mustapha Island consisted of observation of true meridian, trianation, and sounding of both channels, making cross sections of banks and island, king borings as often as was necessary to define the position of the rock ledges, ing topography, and establishing references to the primary points.
evels were run and checked to determine the fall in the water surface, and also r the old stone dam across the back channel at the head of Newberry Bar to nonstrate the condition thereof.
he discussion of conditions characteristic of this locality has been reserved, on ount of impracticability, until after the field notes have been worked up, which not yet been done.
he time consumed by the field work was from September 13 to October 8, 1893.

SURVEY OF HARBOR AT MADISON, IND.

With a view of ascertaining what work is necessary at this point, plementary to the dike recently built and which has not produced desired effect, a party was sent there in September to make a sur-. The report of the work is given below.

[Extract from report of Mr. Edward Schenk.]

accordance with your instructions I proceeded to Madison, Ind., on September 1893. The water gauge at the foot of Mulberry street is marked by a strip of nch iron, upon which the graduations are cut, being spiked to a square oak timrunning up the public wharf, its top surface being flush with the paving. The ge was built during July, 1892, and is graduated from 5 feet to about 45 feet. hority was requested to extend the gauge about 2 feet, but the river rose before work could be done.
stake driven into the gravel served as a gauge during the time of the survey, 5-foot mark on the stake corresponding to 5 feet on the permanent gauge.
ygonal lines were measured on the Kentucky shore from station 0+00, opposite Marine Railway, to station 149+25.00, located at Sniders Landing, Kentucky, ut one-half mile above Madison pump house.
o work could be done September 30 on account of a steady rain all day. Progress ounding main channel (October 1 to 4, inclusive) was slow, because the river had n over the stakes, and much of the line had to be remeasured. Observations e made on Polaris on the night of October 4 for determining the meridian line.
primary triangulation, next executed (October 5 to 8, inclusive), consists of 4 drilaterals, 1 pentagon, and a triangle. A gale on the 6th instant made it almost ossible to work, and not much was done.
orings, 37 in number, were made in the main channel only, at stages varying

from 6.8 to 7.9 on the gauge, about 400 feet apart on lines about 1,000 feet apart. Boring was extremely difficult on account of the deep water and swift current. The bottom was found to be very hard in most places. No rock was encountered, but a hard, coarse gravel, which seems to be cemented with lime, as the points of the rods indicated on being drawn out, was frequently met along the Indiana shore in the vicinity of the dike. Two steel-pointed boring rods (1 inch and ¾ inch square) were each broken in pulling them out of the gravel, which required 5 men on a 15-foot lever, applied in the middle of the gunnel of a small flatboat 12 by 40 feet. The flat was held in position by three anchors; one was placed upstream from the boat and one on each side.

Six days (October 12 to 18) were devoted to making cross sections, taking up detail, and marking stations as much as possible.

The elevations of the high water of February 15, 1883, and February 16, 1884, were referred to the permanent gauge at the foot of Mulberry street by a line of levels to the above high-water marks on buildings. The elevations are as follows:

	Feet.
Flood of February 15, 1883	59.45
Flood of February 16, 1884	61.75

High water made it impracticable to continue the work, so I returned to Cincinnati October 19, 1893. The work has not yet been platted.

SURVEY AT FOOT OF FRENCH ISLAND, OHIO RIVER.

[Extract from report of Mr. H. Devereux.]

The survey was begun in October, 1893, a base line being run from station 0, at the lower end of the Indiana side, to the foot of the island, 5,837 feet, and from the foot of the island 3,000 feet up the channel side of same, stakes being put in 200 feet apart and at changes of direction in the line. The base line was measured with a 100-foot steel tape. Stakes were numbered consecutively from 0 to 58+36.95 on Indiana and from 0 to 30 on the island base line, and each stake centered with a tack.

Beginning with station 0, lines at right angles to this part of the base line were turned, and stakes correspondingly numbered placed on the Kentucky side of the river; this method was pursued throughout, except that lines parallel to the first were used to prevent overlapping of sounding lines.

Soundings were made with a 15-foot rod divided into feet and tenths, from a skiff rowed by two oarsmen, the soundings being taken from the bow and recorded by a man in the stern. An angle was taken at each measurement with an instrument located on the base line, the skiff being kept in line by a man located on each side of the river. The time and variation of gauge was noted at the beginning of each line. The banks were too steep and the water line too close to them to permit of using alignment rods to guide the rowers in crossing the river with lines of soundings.

A complete system of triangulations was made; the banks were located by separate instrument lines, distances being measured at each 100 feet to the top of the bank; all trees, roads, houses, etc., were carefully noted.

The dikes were located by separate lines and triangulations, the old dike built in 1832 being checked by measurements which had been made during the previous low-water season.

Cross sections of the banks were taken at every change in slope, and are shown by red figures giving elevation above low water.

The banks were so steep and badly washed that it was found impracticable to use an ordinary surveyor's level in cross sectioning. A rod 10 feet long, divided into feet, with level bulbs in each end, was used in carrying a horizontal level, and gave satisfaction.

1832 Dike.—An opening 370 feet in length, beginning at the present floating light, was made by the dredge boats in 1892; this was the only available channel for boats during the season of 1893. About 1,200 feet (linear) of the old dike was removed at the same time, leaving about 1,800 linear feet of old dike yet to be taken out. 1,000 feet lying opposite No. 1 Spur Dike, and about 800 feet with scattered stones opposite No. 2 Spur Dike.

1873 Dike.—Repaired in 1874–'75; is in good condition; built of piles, brush, and stone; about 40 feet wide. The first 1,800 feet from the root averages 6 feet above low water, decreasing at lower end to 3 feet above low water.

Spur dikes.—The spur dikes were in process of construction at the time of the survey and had not been completely filled with stone when the soundings were taken, and no scouring of the bar could at that time have been caused from them.

Dam.—The dam is shown on a copy of a survey made in August, 1892, which determined its location. The construction of the dam caused some slight changes in cross section, and will result in practically closing up this chute except in very high water.

Map.—The map was platted by method of coordinates. The soundings were reduced to low water by subtracting 4.1, 4.4, 4.5, 4.7, 4.8, 5, and 7.2 feet from the daily readings of a gauge located 800 feet below the Government light on the Kentucky side. This gauge was compared with a gauge at the dam and one at Indiana Government light. The gauges are the same, and agree with the Evansville gauge from 1.8 up to 12 feet, which was the greatest noted. Below 1.8 to 1.5, the lowest at Evansville this season, the upper gauge remained stationary, a scour of 12 inches being noted in the 370-foot opening of the old dike. This filled up, however, when the river reached 4 feet in rising.

Low water.—0.1 foot on the gauge at Evansville was taken as low water at French Island.

Banks.—A comparison of this map with one of a survey made in 1887 shows that the banks have washed from 60 to 120 feet back on the Kentucky side from the root of the 1873 Dike up. On the Indiana side the banks have washed an average of 60 feet, beginning at a point on the Indiana bank opposite Spur Dike No. 2, and continuing down the river. The washing of the Kentucky bank is continuing rapidly.

The chute side of the island seems to be washing, or possibly to be making ground and gradually getting higher, but not as wide as shown in 1887.

The whole bar and crossing is shoaler than in 1887.

Coal shipments from Pittsburg, Pa.

[Furnished by Capt. William Evans.]

Months.	To Cincinnati.					To Louisville.				
	Trips.	Coal boats.	Coal barges.	Fuel flats.	Tons.	Trips.	Coal boats.	Coal barges.	Fuel flats.	Tons.
1893.										
February	10	19	68	4	53,433	11	50	52	.....	76,680
March	6	.....	77	.....	36,975	10	30	93	8	72,104
April	19	15	201	3	113,822	55	173	373	28	445,067
May	28	46	317	4	205,311	42	254	233	8	363,744
June	2	.....	15	.....	7,575	.....	.....	.....	.....	.....
September	1	1	10	.....	4,738	1	1	10	.....	4,737
October	4	4	40	.....	15,380	1	1	12	.....	4,168
November	40	28	472	.....	245,380	28	58	303	.....	186,611
December	27	32	318	.....	147,264	43	319	153	10	381,412
Total	137	145	1,518	11	829,878	191	886	1,229	54	1,534,523
Grand total	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,364,401

Comparative table showing coal shipments from Pittsburg during the ten years ending December 31, 1893.

Year.	To Cincinnati.	To Louisville.	Total.	Year.	To Cincinnati.	To Louisville.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1884	946,124	1,160,292	2,106,416	1889	1,149,892	1,439,747	2,589,639
1885	1,733,104	1,114,008	2,847,112	1890	1,324,641	2,095,716	3,420,357
1886	1,262,702	2,220,530	3,483,232	1891	1,065,705	1,828,047	2,893,752
1887	788,690	1,367,012	2,155,702	1892	914,430	1,384,864	2,299,294
1888	1,950,882	2,223,494	4,174,376	1893	829,878	1,534,523	2,364,401

Commerce passing Davis Island Dam in 1893.

Vessels.	Ascending.				Descending.				Total freight.
	Through lock.		Through pass.		Through lock.		Through pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	74	3,006	263	33,182	69	3,215	247	29,673	69,076
Towboats	248	.....	1,032	.....	237	.....	1,064	.....	.....
Model barges	14	.....	44	1,100	2	1,200	52	38,112	40,412
Coal boats	66	.....	210	.....	20	10,642	1,166	1,220,848	1,231,490
Barges	350	3,200	2,233	8,725	271	103,413	2,837	1,122,130	1,237,468
Flats	304	2,935	847	10,150	386	41,411	1,136	223,415	277,911
Rafts	1	25	.....	.....	15	4,623	65	235,432	240,080
Miscellaneous	27	.....	78	.....	61	.....	87	.....	.....
Total	1,084	9,166	4,707	53,157	1,061	164,504	6,654	2,869,610	3,096,437

Commerce passing Lock No. 6, near Beaver, Pa.

Vessels.	Ascending.		Descending.	
	No.	Freight.	No.	Freight.
		Tons.		*Tons.*
Packets	319	34,380	317	34,175
Towboats	863	.....	860	.....
Model barges	58	.....	54	51,300
Coal boats	876	.....	1,106	995,400
Barges	580	1,500	3,108	1,653,456
Flats	780	12,075	1,050	159,600
Rafts	.....	.....	59	177,000
Total	3,476	47,955	6,554	3,070,931

River commerce of Cincinnati for the year ending December 31, 1893.

Articles.	Receipts.	Shipments.	Total.	Articles.	Receipts.	Shipments.	Total.
	Tons.	*Tons.*	*Tons*		*Tons.*	*Tons.*	*Tons.*
Alcohol	.....	50	50	Lead, white	.....	354	354
Ale, beer, and porter	12	854	866	Leather	240	86	326
Apples, green	730	258	988	Lemons	.....	77	77
Bagging	.....	47	47	Lime	587	465	1,052
Barley	8	.....	8	Lumber	928	368	1,296
Beans	44	193	237	Malt	74	152	226
Beef	.....	1	1	Manufactures, sundry	.....	105	105
Boots and shoes	35	275	310	Merchandise	79,316	36,766	116,082
Bran, middlings, etc	72	46	118	Molasses	3,047	1,864	4,911
Brooms	.....	47	47	Nails	9,515	7,151	16,666
Butter	66	12	78	Oats	20	275	301
Candles	.....	13	13	Oil	94	522	616
Castings	857	1,077	1,934	Onions	91	139	230
Cattle	3,039	286	3,325	Oranges	.....	387	387
Cement and plaster	1,255	935	2,190	Peanuts	771	389	1,160
Cheese	1	44	45	Petroleum	478	1,153	1,631
Cider	205	199	404	Potatoes	3,737	2,697	6,434
Coffee	12	1,046	1,058	Rice	1,224	228	1,452
Cooperage	31	78	109	Rope, twine, etc	1,223	2,636	3,859
Corn	2,022	229	2,251	Rosin	.....	64	64
Corn meal	2	327	329	Rye	81	99	180
Cotton	4,246	266	4,512	Salt	14,085	11,485	25,570
Crockery	242	364	606	Seed, clover and timothy	185	703	888
Eggs	370	23	393	Sheep	914	19	933
Feathers	16	3	19	Shot	.....	30	30
Fish	24	423	447	Soap	23	257	280
Flour	1,024	1,986	3,010	Sorghum	532	59	591
Fruit, dried	62	65	127	Spices	.....	1	1
Fruit, green	165	12	177	Starch	4	27	31
Furniture	.....	637	637	Sugar	2,247	2,227	4,474
Glass, window	72	70	142	Tobacco, leaf	10,577	1,806	12,383
Glassware	1,795	2,105	3,900	Tobacco, manufactured	127	239	366
Grease	81	52	133	Turpentine	3	31	34
Hardware	1,806	3,481	5,287	Vegetables, green	426	168	594
Hay	4,737	415	5,152	Vinegar	.....	835	835
Hides	205	64	269	Wheat	4,298	864	5,162
Hog products	11	1,619	1,630	Whisky	7,056	4,377	11,433
Hogs	5,334	43	5,377	Wines and liquors	76	230	306
Hops	.....	5	5	Wool	111	41	152
Horses	463	721	1,184	Yarn, cotton	277	.....	277
Iron and steel	20,568	18,182	38,750				
Iron and steel, scrap	357	10	367				
Iron, pig	12,404	17,405	29,809				

RECAPITULATION.

	Tons.
Receipts	204,749
Shipments	133,344
Total	338,093

Arrivals and departures of steamboats at the port of Cincinnati, Ohio.

Year.	Arrivals.				Departures.			
	From New Orleans.	From Pittsburg, Pa.	From other ports.	Total.	From New Orleans.	From Pittsburg, Pa.	From other ports.	Total.
Fiscal year:								
1885–'86	63	103	2,323	2,489	66	103	2,314	2,483
1886–'87	34	69	2,169	2,272	38	70	2,173	2,281
1887–'88	35	156	1,389	1,580	37	153	1,385	1,575
1888–'89	51	237	2,233	2,521	51	237	2,234	2,522
1889–'90	38	197	2,022	2,257	37	194	2,021	2,252
1890–'91	31	208	1,995	2,234	31	207	1,996	2,234
1891–'92	23	204	1,958	2,185	23	202	1,963	2,188
Calendar year:								
1892	20	186	1,846	2,052	22	185	1,854	2,062
1893	17	120	1,754	1,891	17	120	1,757	1,894

Schedule of rates on flour per barrel by rail and river from Cincinnati for eight years ending December 31, 1893.

Year.	To Pittsburg.		To Louisville.		To New Orleans.		To Memphis.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1886	26–31	15–20	15	15	44	35–39	.....	.....
1887	24–31	15	15	15	44–49	35	.....	.....
1888	22–24	15	15	15	40–49	35	.....	.....
1889	23	15	15	15	54	35	.....	.....
1890	23–24	15	15	15	49–54	35	.....	.....
1891	24	15	15	15	49	35	.....	.....
1892	24	15	15	15	49	35	40	30
1893	24	15–20	15	15–10	49	35–30	40	30–40

Comparative statement of commerce passing the falls of the Ohio River by canal and by river.

Year.	Canal.		Open river.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1882	3,988	935,628	2,305	668,866	6,293	1,604,494
1883	5,231	1,349,115	1,484	483,281	6,715	1,832,396
1884	3,485	785,192	1,548	484,124	5,033	1,269,316
1885	5,678	1,443,181	822	262,862	6,500	1,706,043
1886	4,964	1,240,112	1,796	577,547	6,760	1,817,659
1887	4,069	867,807	2,297	1,204,518	6,366	2,072,325
1888	6,963	1,915,365	2,252	1,162,305	9,215	3,077,670
1889	5,534	1,404,573	1,984	957,829	7,518	2,362,402
1890	4,386	998,062	3,828	1,717,158	8,214	2,715,220
1891	4,739	1,302,471	2,137	1,062,428	6,876	2,364,899
1892	5,506	1,275,329	1,826	858,953	7,332	2,134,282
1893	3,902	848,211	1,722	514,317	5,624	1,362,528

Commerce of Ohio River in 1893.

Name of boat or company.	Between what points on the Ohio River.	Distance on Ohio River.	Months in commission.	Freight.	Passengers.
		Miles.		*Tons.*	
Coal shipments from Pittsburg.	Pittsburg to Cairo	965	9	2,264,461	
Gray's Iron Line	do	965	4	12,067	
Huntington and St. Louis Towboat Company.	do	965	12	234,108	
A. Montgomery & Co	do	965	7	126,263	
John Barrett & Son	do	965	10	190,000	
Steamer J. T. Jackson and barges.	do	965	3	17,948	
Relief Towboat Co	do	965	8	35,000	
Steamer Hawk	do	965	5	41,312	
Collier, Budd & Co	Pittsburg to Cincinnati	467	12	53,035	
Steamer Lizzie Bay	do	467	11	14,000	7,0
Steamer Iron Queen	do	467	5	19,600	5,4
Steamer Keystone State	do	467	5½	15,250	4,5
Steamer Hudson	do	467	6	9,600	4,2
Steamer Scotia	do	467	5	10,800	3,0
Steamer C. W. Batchelor	do	467	6	7,563	10,1
Steamer Elaine	do	467	12	45,896	1
Steamer Adelle	do	467	5	18,791	
Steamer Jim McConnell	Pittsburg to Point Pleasant.	263½	5	75,000	
Steamer Ben Hur	Pittsburg to Parkersburg	183	8½	7,060	5,5
Steamer Courier	do	183	6	8,746	4,3
Steamer Sunshine	do	183	3	5,172	2,1
Steamer Annie Laurie	Pittsburg to Marietta	171	5	3,500	1,5
Steamer H. K. Bedford	Pittsburg to Newport	156½	9	6,609	3,5
Hulings Bros	Pittsburg to Bellaire	94	10	15,060	
Steamer Olivette	East Liverpool to Steubenville.	23	7	2,600	3,1
Steamer Liberty	Wheeling to Clarington	28	12	670	9,7
Steamer R. E. Phillips	Wheeling to Matamoras	51	5	1,000	12,6
Steamer T. N. Barnsdall	Matamoras to Marietta	30	8½	4,080	6,8
Marmet & Co	Marietta to Caseyville	689	8	188,619	
Steamer Lyde H	Marietta to Long Bottom	36	6	1,165	9,3
Steamer Harry D. Knox	Marietta to Middleport	78½	7	3,534	1,7
Steamer C. C. Martin	do	78½	9½	1,087	2,0
Steamer Columbia	Marietta to Gallipolis	96	5	5,230	2,2
Steamer Capitol City	do	96	5	5,200	2,0
Steamer Valley Belle	Ravenswood to Middleport	34	8	9,460	4,0
Steamer C. A. Hill	Syracuse to Gallipolis	24	9	6,740	12,6
Steamer J. M. Clark	Syracuse to Cincinnati	224	7	20,000	
Syracuse Coal and Salt Co	do	224	12	28,035	
Steamer Geo. W. Moredock	do	224	10	70,176	
Thomas J. Hall	Pomeroy to New Albany	354	11	30,000	
Pomeroy, Cincinnati and Louisville Barge Line.	Pomeroy to Louisville	349½	8	200,000	
Steamer F. J. O'Connell	do	349½	4	45,000	
Steamer Crown Hill	do	349½	8	168,000	
Steamer J. H. McConnell	Pomeroy to Cincinnati	219	9	150,750	
The Jessie Towboat Co	do	219	7	650	
Steamer Wm. Wormald	do	219	12	43,400	
Pomeroy and Cincinnati Packet Co.*	do	219	10	92,244	2
John Taylor & Sons	Middleport to Cincinnati	217	9	12,000	
Ella Layman Towboat Co	Point Pleasant to Louisville.	335	6	229,465	
Steamer Al Martin	do	335	12	183,325	
Armstrong Bros	Point Pleasant to Cincinnati.	203	6	43,300	
Kanawha and Ohio Transportation Co.	do	203	7	140,111	
Steamer Henry M. Stanley	do	203	11	20,394	
Steamer Coal Bluff	do	203	9	110,[illegible]	
Yellow Poplar Lumber Co	Point Pleasant to Portsmouth.	90	12	100,90[illegible]	
Ironton Cross-tie Co	Point Pleasant to Ironton.	62½	12	49,0[illegible]	
Steamer Lee H. Brooks	Gallipolis to Portsmouth	86½	3	[illegible]10	
Steamer Carrie Brown	Gallipolis to Huntington	47	10	3,1[illegible]53	
Steamer Vesper	do	47	8	4,1[illegible]14	
Steamer Chevalier	Proctorville to Portsmouth	50½	9	14,0[illegible]00	
Steamer Tom Spurlock	Guyandotte to Portsmouth	50½	5	87,[illegible]00	
Steamer Georgia	Huntington to Ironton	19	5	10	
Steamer Ruth	do	19	6	50	
Ashland Coal and Iron Railway Co.	Huntington to Portsmouth	47	11	5,[illegible]000	

* Three boats from Cincinnati to Pomeroy; one boat from Cincinnati to Manch[illegible]ste

Commerce of Ohio River in 1893—Continued.

of boat or company.	Between what points on the Ohio River.	Distance on Ohio River.	Months in commission.	Freight.	Passengers.
		Miles.		*Tons.*	
n Towboat Co	Catlettsburg to Louisville.	284	9	62,760	.....
Jerrie	Ashland to Ironton	5	4	.....	6,687
R. Ware	Ashland to Cincinnati	147	9	12,001	.....
Reliance	Portsmouth to Rome	27	10	1,918	7,087
Henrietta	Portsmouth to Louisville	245	8	.....	2,850
Vista Freestone Co	Buena Vista to Cincinnati	95½	11	20,000	.....
Bellevue	do	95½	10	40,000	.....
Rob Roy	Buena Vista to Addyston	109	5	5,000	.....
Silver Wave	Vanceburg to Maysville	30	.....	.....	.....
ith Coal and Sand Co.	Manchester to Addyston	86	12	50,000	.....
M. P. Wells	Maysville to Augusta	19½	8	3,000	6,000
app	Beasley Creek to Cincinnati.	54	9	10,040	.....
Tacoma	Chilo to Cincinnati	35	10	16,000	15,000
Towboat Co	New Richmond to Aurora	47	8	700,000	.....
ney Island Co	Coney Island to Cincinnati.	10	3	534	268,560
Spillie & Son	Dayton to Cincinnati	3	9	5,000	.....
leming	Newport to Petersburg	25	11	10,249	.....
Alice L. Barr	Cincinnati Harbor	.....	11	100,300	.....
Levi J. Workum	Cincinnati to Petersburg	25	12	6,743	918
ati and Louisville Line Co.*	Cincinnati to Louisville	132	10	103,708	84,641
S. R. Van Metre	do	132	1½	2,000	782
ati and Madison et Co.	Cincinnati to Cairo	499	7	57,454	7,949
U. P. Schenck	do	499	6	5,500	225
State of Missouri	do	499	4	8,000	240
Mayflower	Lawrenceburg to Aurora	3	12	50	5,000
Swan	Aurora to Rising Sun	10	4	37	136
Ghent	Aurora to Carrollton	48	7	300	1,300
Falls City	Carrollton to Louisville	58	11	17,964	7,468
Rescue	do	58	5	3,000	1,008
Jim Montgomery	Madison to Bethlehem	18	9	1,500	7,000
Ada V	Madison to French Island	208	4	7,300	.....
Henry Logan	Louisville to Derby	88	10	3,360	180
lle and Evansville Line Co.*	Louisville to Henderson	197	10½	108,285	32,794
Racket	Louisville to Cairo	367	4	7,500	100
Stone Wave	do	367	4	5,000	.....
Eugene	Cannelton to Paducah	203	10	11,875	.....
Judelle	Hawesville to Owensboro	32	12	4,865	11,128
G. B. Monteith	Hawesville to Mouth Tradewater River.	145	6	7,280	.....
Jewel	Owensboro to Henderson	46	6	4,641	15,012
Royal	do	46	10	9,656	37,432
Rosedale	Owensboro to Paducah	171	8	2,275	2,600
Edwin J. Woods	Mouth Green River to Evansville.	8	3	360	1,800
T. C. Woodward	do	8	5	110	1,760
gle & Co	do	8	12	290,000	.....
W. K. Phillips	Evansville to Smithland	125	8	6,152	802
D. A. Brooks	Evansville to Paducah	137	12	21,680	402
ille, Paducah and esaee River Packet Co.	do	137	12	15,333	2,400
Joe Fowler	do	137	11	10,535	11,876
John S. Hopkins	Evansville to Paducah	137	12	12,150	13,722
Maggie Bell	Evansville to Cairo	182	10	2,300	.....
Monie Bauer	Caseyville to Cairo	105½	6½	5,620	486
Grace Morris	Caseyville to Paducah	60	10	1,500	5,321
Gus Fowler	Elizabethtown to Paducah	43	12	6,520	4,427
Corinne No. 2	Bay City to Cairo	67	4	1,582	.....
lle, Paducah and Packet Co.	Smithland to Paducah	12	11	9,433	2,600
City of Metropolis	Paducah to Metropolis	9	12	2,445	23,013
Dick Fowler	Paducah to Cairo	45	10	10,400	27,600
City of Sheffield	do	45	9	24,500	1,375
City of Savannah	do	45	11	31,750	1,640
City of Paducah	do	45	12	6,287	2,092
Fred Nellis	do	45	12	11,173	.....
I. N. Hook	do	45	12	61,000	.....
aty	do	45	2	8,132	.....
otal				7,371,804	858,797

boats to Louisville; two boats to Madison; one boat Patriot to Madison; one boat Carrollton sville.

D D 2.

OPERATING SNAG BOAT ON OHIO RIVER.

The river and harbor act of September 19, 1890, contained the following item:

SEC. 13. That for the purpose of securing the uninterrupted work of operating snag boats on the Ohio River, and removing snags, wrecks, and other obstructions in said river, the Secretary of War, upon the application of the Chief of Engineers, is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the sum of twenty-five thousand dollars: *Provided, however*, That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The object of the above provision was undoubtedly to provide funds for the constant operating of the snag boat in the most efficient manner, without subjecting her important service to the uncertainties arising from the failure of yearly appropriations. The provision is one of great importance to the navigation interests of the Ohio River, and the work of the snag boat in removing snags and wrecks has done much toward increasing the safety and ease of navigation. The amount of $25,000 per year, which is authorized to be expended for this service, is not sufficient to keep the boat employed for the length of time that she should be each year, and to provide for repairs. The boat is well adapted for her work, but the work is very heavy and necessitates much renewal of various parts of machinery and outfit; besides, the boat is getting old and requires considerable repairs each year to keep her in effective working condition. To keep within the amount allotted it is necessary to lay the boat up for a part of the year when she might be usefully employed, and some parts of the river are not visited as often as they should be. I would earnestly recommend that the amount to be available each year should be increased to $50,000, or so much of that amount as might be necessary. With that amount the boat would be kept constantly in highly effective condition, could start out early enough each season to go over the entire river at least once, and most of the distance twice, and would make her service entirely satisfactory to the navigation interests.

The repairs to the snag boat prior to commencing the season's work in 1893 were those only which were of the most urgent character. The boat worked from June 27 to November 13, 1893, when she was ordered into winter quarters. In that time she removed 810 snags, 70 wrecks, 59 piles, 45 cubic yards stone, and 1 pile of mixed sawmill slabs and earth. The boat traveled a total distance of 3,113½ miles, much of it at a time when the river was so low that general navigation was suspended.

To prepare for the coming season's work, the boat left her winter quarters February 27 and was brought to Cincinnati. The repairs were completed June 30, and the boat is now ready to begin work. It could have been ready to begin the season's operations by the last of April if there had been a sufficient amount available for her work, and she could have commenced at the head of the river. The lack of funds has therefore resulted in the loss of two months' time of work and the probability of the boat not being able to get up to Pittsburg on account of the low stage of the river.

The work of the snag boat has been under the supervision of Capt. W. H. Christian.

OPERATIONS.

[Extract from report of Capt. W. H. Christian.]

snag boat remained in winter quarters in the mouth of the Kentucky River March 2, 1893, when, pursuant to orders, she started for Cincinnati, 75 miles t, reaching her destination March 3.

ual repairs to put the boat in effective working condition to improve naviga- n the Ohio River, by removing obstructions therefrom, were begun March 11 mpleted June 7.

items of repair this year were many, and among the most important and ensable were those made to the propelling, wrecking, hoisting, capstan and g engines, furnaces of main and auxiliary boilers, main deck and guards, which ed new iron plates in place of the old that had been eaten up with rust; ing two worn-out hull straps with new ones, replacing with new fifteen worn- k stationary stanchions, which are used as stationary fenders and chief outside deck supports; rebuilding two main capstan barrels with locust timber, iron and bolts, and constructing and putting in position one new rudder. Also ucting foundations, erecting and equipping, complete, ready for operating, two apstan engines, capstans and machinery belonging to same, all of which, due k of funds to erect them before, had been carried on the boat, unserviceable, their delivery in September, 1891.

r completing repairs and providing for all liabilities of the snag boat from allotted for the fiscal year ending June 30, 1893, there remained a balance suf- to put the boat in commission for four days in June. Accordingly, on the lay of June the snag boat left Cincinnati, Ohio, and proceeded upstream 466¼ to Pittsburg, Pa., arriving July 1. On account of a rapid fall of the river, the boat ittsburg a few hours after her arrival and commenced the removal of obstruc- going downstream as far as Cairo, Ill., 967 miles, arriving September 15. On ate the boat was headed upstream and worked as far as Beaver Dam, 30 miles Pittsburg, arriving October 20. At this time the river was falling rapidly as too low to permit the boat to proceed farther upstream, so she was headed tream and continued her regular work until November 13, when, in pursu- f orders, she went into the mouth of Kentucky River, 541 miles below Pitts- for a safe harbor during the coming winter, where, after putting the property at in proper order, she went out of commission on November 15, 1893. The except the watchmen, who remained with the captain in charge of the prop- were paid off and sent home.

n June 27 to November 13, 1893, the snag boat traveled 3,113¼ miles, removed bstructions, spent fourteen hours dragging over locations of old wrecks and ng the crust of a few sand bars to assist scouring. In connection with the , it is only proper to add that, on August 8, very low water was encountered, continued until September 7, greatly retarding the movements and progress snag boat, and, as a result, the low water, coupled with the necessity for tak- lvantage of it to remove some serious low-water obstructions which high of water always covered with sand, forbidding then their discovery and al, the boat, which displaces about 900 tons, had to be sparred over sand t Blue River Island, Flint Island, Fulton (Ind.) Coal Works, Rockport, 1 Island-head, French Island-foot, Vannadas, and Scuffletown. Those bars aving over them from 4 inches to 12 inches less water than the draft of the imposed much hard work, and was very destructive to the capstan machinery ar rigging.

Woodruff was in commission one hundred and forty-two days, and during that as employed as follows:

	Days.
ng from Cincinnati to Pittsburg	4
ing and wrecking	88
ing exclusively	8
ng and incidental repairs	19
ys tied up	18
ys worked, sparring and repairing	5
Total	142

oved 810 snags, 70 wrecks, 59 piles, 45 cubic yards of stone, 1 pile of mixed ll slabs and earth. During the eighty-eight days credited to snagging and ing, the snag boat dragged a number of landings and places in the channel, obstructions were supposed to have lodged, without finding anything.

Wrecks removed, classified, are as follows:

	Number.
Steamboat hulls	6
Coal boats, barges, and flats	54
Wharf boats	2
Flatboats and produce boats	6
Model barge	1
Salt barge	1
Total	70

From the snags removed from the channel, the following, each weighing more than 50 tons, have been selected, and their locations distant from Pittsburg given, to show that the large snags removed are not peculiar to any particular section of the river:

Location.	Weight.	Miles below Pittsburg.
	Tons.	
1 in front of Knoxs Shipyard	83. 183	171½
1 above Siolam Landing	62. 866	346
1 in front of Kramers Landing*	13. 716	449½
1 in front of Jenkins Landing	143. 000	561
1 in front of Widow Stewarts Landing	118. 000	621
1 in front of Widow Stewarts Landing	135. 866	631
1 in front of Widow Stewarts Landing	65. 773	621
1 in front of Larkins Ferry Landing	64. 490	753
1 in front of Larkins Ferry Landing	63. 980	752
1 in front of Carsons Landing	56. 000	794
1 at head of Diamond Island	183. 600	808
1 at head of Diamond Island	101. 920	808
1 in front of Uniontown	88. 266	833
1 in front of Uniontown	97. 516	833
1 in front of Idlewild Landing	60. 933	845
1 in front of Lamberts Landing	129 533	851½
1 in front of Gehagans Landing	106. 860	863
1 in bend below Bartons Landing	63. 858	887
1 in bend below Bartons Landing	139. 076	897

*The snag removed from in front of Kramers Landing, weighing less than 50 tons, is included in the list, to be noted as having sunk the Cincinnati and Chilo packet *Minnie Bay*, in the month of October, 1889.

Itemized statement of expenses for operating snag boat on the Ohio River, and removing snags, wrecks, and other obstructions in said river.

EXPENSES OF UNITED STATES SNAG BOAT E. A. WOODRUFF.

Month.	Pay of crew.	Subsistence.	Fuel.	Miscellaneous supplies.	Tools and implements.	General repairs and betterment.	Contingent expenses.	Total.
1893.								
July	$2, 011. 66	$874. 19	$235. 14	$869. 85	$227. 20	$211. 46	$18. 32	$4, 447. 82
August	2, 002. 46	471. 86	252. 76	24. 97	1. 35	83. 10	3. 51	2, 840. 01
September	1, 983. 99	641. 42	373. 33	102. 05	6. 75	52. 86	31. 47	3, 191. 87
October	2, 053. 32	416. 81	519. 56	30. 93	.....	282: 68	5. 11	3, 308. 41
November	1, 184. 75	174. 33	168. 85	178. 70	.....	.....	61. 60	1, 768. 23
December	467. 50	38. 61	.....	.....	. 20	17 90	5. 14	529. 35
1894.								
January	437. 50	27. 47	.....	10. 38	.....	.....	.....	475. 35
February	522. 80	46. 58	27. 50	.....	.....	6. 08	20. 20	623. 16
March	403. 00	.....	.....	3. 00	.....	674. 39	24. 85	1, 105. 24
April	390. 00	.....	.....	.....	22. 05	3, 629. 95	15. 00	4, 057. 00
May	400. 00	.....	00. 48	.....	.....	1, 260. 40	.....	1, 720. 88
June	507. 19	76. 52	84. 94	38. 34	12. 45	195. 79	11. 85	927. 08
Total	12, 361. 17	2, 767. 79	1, 722. 56	1, 258. 22	270. 00	6, 414. 61	197. 05	24, 994. 40

D D 3.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER, NEAR PITTSBURG, PENNSYLVANIA.

This work has been under the immediate supervision of Mr. William Martin, assistant engineer.

The following is a statement of the amount and date of all allotments for this work:

August 3, 1885	$5,865.00	July 17, 1890	$14,752.00
July 10, 1886	12,015.00	October 7, 1890	14,800.00
January 28, 1887	6,700.00	July 10, 1891	10,338.00
July 1, 1887	12,355.00	July 21, 1892	11,831.48
February 25, 1888	3,500.00	June 27, 1893	1,300.00
July 11, 1888	18,015.00	July 22, 1893	12,253.82
August 20, 1889	12,073.00		
May 14, 1890	2,000.00	Total	137,798.30

At the close of the last fiscal year the dam was up, having been raised June 13, 1893. The maneuvers during the year were as follows:

Dam lowered November 30, 1893.
Dam raised May 14, 1894.
Dam lowered May 18, 1894.
Dam raised June 15, 1894.

The dam was thus raised and lowered twice and was up one hundred and seventy-two days. At the close of the year the dam was up.

The lock has been in working order throughout the year. New chain fastening timbers were put in the gates and supplied with cast-iron caps to prevent wear of the timber. As these gates are now some 10 years old they will soon require renewal. It is proposed to embody in the new gates certain improvements which experience with the present ones shows would be advantageous. The present maneuvering boat, which is built of wood, also needs replacing by one of improved design and with more powerful machinery. New and improved screens were placed over the bear trap admission valves.

The house on Davis Island used for quarters for the dam-tenders having become extremely dilapidated and unfit for the purpose, a new house was erected during the year and minor repairs made to other buildings. Also a new tool and store house was erected on Davis Island.

The Back River Dam was repaired and placed in good condition throughout.

The lower guiding crib to the lock was repaired where it had been damaged by ice, and a cap of angle iron put on to prevent future damage. Several bins of the crib have been filled with stone. As an experiment, the six bins at the upper end have been surfaced with a natural cement concrete and have stood the weather very well.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. William Martin.]

Lock.—The lock has been in satisfactory working order throughout the year. No repairs were required, except to the chain fastenings on the lock gates. These fastenings are large timbers to which are attached tug links to take the shock from the engines. The new timbers have been supplied with a cast-iron cap on the outer end, which permits the chain to slip around in response to the action of the tug links. The lock gates, which are built of pine timber, are now 10 years old, having been built about one year before being put into actual use. Experience has brought out defects in the construction of these gates that are great drawbacks to their free operation. The principal defect I might mention is the lateral sliding action of the gate on its wheels. This action produces such a great strain on the lower structure of the gate that it is rapidly destroying it. The upper members of the gates are becoming

very soft and in many places quite rotten. There has been extensive repairs made to the gates at various times, but I am of the opinion that the only proper thing to do is the complete renewal of the gate built, by one with improvements our experience has suggested. Some steps should be taken toward having new gates ready, as the failure of the present ones might occur at any time.

Back River Dam.—This structure is 475 feet long. During the year it has received a general repairing, consisting of a renewal of about two-thirds of the lower slope and apron, and 6 feet of the upper slope. This places the dam in good condition, and I do not anticipate any further repairs necessary for some years.

Lower guiding crib.—The top outer timber of the new portion of the lower guiding crib was badly cut away by the ice; this has been capped with angle iron as a protection. Several bins have been partially filled with stone. The six bins at the upper end of the crib were surfaced with concrete made from natural cement as an experiment. They have stood the weather exceedingly well, and I believe if the top surface were made with Portland cement it would be a good plan to adopt in the case of similar cribs.

Awning for lock-keeper's house.—Drawings for a wrought-iron awning to take the place of the upper porch of the lock-keeper's house were prepared last year. The work was commenced July 1 and finished August 3, 1893, by Messrs. Riter & Conley, of Pittsburg, Pa.

Tool house.—A tool house and winch shed, 20 by 50 feet, has been built on Davis Island for the storage of Government property. The building can also be used as a workshop. It is located on the line of the dam near the bank, and is elevated about 5 feet above the ground, out of reach of all except extraordinary floods. A track is constructed beneath the building where the wicket and service bridge winches are kept when the dam is down, and their use is not required. The upstream posts are sunk to a depth of 5 feet, on the bottom of which are secured large cast-iron disks, to serve as an anchor in case of the building being submerged by a very high flood.

Quarters on Davis Island.—During the year a frame house of 8 rooms, designed after the "half colonial" style of architecture, was erected on Davis Island. The building is intended as a residence for the dam-tender and his assistant dam-tenders. The old quarters were torn down.

Buildings.—The outside of the lock-keeper's house has been renovated by a coat of light olive-green paint; the windows, doors, and cornices were painted a dark green. All the other buildings, both on the lock and island side of the river, are painted the same colors.

Natural gas.—Natural gas is still used as light and fuel, and is received at the same rates and from the same company as heretofore, viz, the Bellevue and Glenfield Natural Gas Company, at $350 per annum.

Repair of Bear Trap Pier.—The north pier of the Bear Trap chute was injured by the steamer *Return*. The matter was referred to in the last Annual Report. The owners of the boat have paid the expenses of making the repairs.

Movable dam.—No injury or accident has occurred to the Chanoine or Bear Trap Dam. The screens on the Bear Trap admission valves, which were of ¼-inch round iron, having a square mesh of 1¼ inches, were in bad condition and required renewal. They were replaced by screens with vertical bars ¼ by 1¼ inches; this form makes it easy to keep the screen clean of matter which is drawn against it, closing the water passage. These screens are examined every morning, and any accumulation of débris is cleared off, giving the valves the full water area.

Maneuvering boat.—The maneuvering boat is a wooden one, and has now been in service eight years, and is in a very advanced stage of decay. When the boat was built our experience was limited, and it is lacking in many points of advantage which experience has brought out. The engine on the boat for maneuvering the dam is too small, and should be replaced by one having a large increase of power.

Operation of dam.—The dam was up on July 1, 1893, and was maneuvered during the year on the following dates: Lowered November 30, 1893, and May 18, 1894; raised May 14 and June 15, 1894.

tion in days of the various stages of water in the Ohio River at the Davis Island Dam from October 7, 1885, to the close of the fiscal year, June 30, 1894.

Month.	1885–'86.			1886–'87.			1887–'88.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
.....	.....	.....	.....	7	24	0	21	10	0
it	.....	.....	.....	7	24	3	27	4	0
ıber	.....	.....	.....	19	11	0	30	0	0
r	12	19	7	26	5	0	30	1	0
ıber.....	0	30	22	12	18	16	19	11	0
ber	0	31	27	0	31	22	2	29	0
ry.....	0	31	28	0	31	17	1	30	19
ary.....	0	28	21	0	28	28	0	29	26
.....	0	31	17	0	31	18	0	31	29
.....	0	30	21	0	30	13	0	30	25
.....	0	31	11	0	31	16	0	31	13
.....	2	28	5	3	27	7	1	29	2
Year	14	259	159	74	291	140	131	235	114

Month.	1888–'89.			1889–'90.			1890–'91.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
.....	3	28	8	0	31	13	14	17	1
it	13	18	6	5	26	2	13	18	9
aber	1	29	6	18	12	0	0	30	21
r	1	30	23	6	25	3	0	31	31
ıber.....	0	30	26	0	30	30	0	30	29
ber	0	31	18	0	31	31	0	31	17
ry.....	0	31	30	0	31	31	0	31	31
ary	0	28	13	0	28	28	0	28	25
.....	0	31	29	0	31	31	0	31	31
.....	0	30	25	0	30	26	0	30	26
.....	0	31	21	0	31	31	1	30	0
.....	0	30	30	0	30	31	0	30	21
Year	18	347	235	29	336	247	28	337	245

Month.	1891–'92.			1892–'93.			1893–'94.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
.....	0	31	13	0	31	5	10	21	0
t	0	31	12	14	17	0	29	2	0
ıber	9	21	4	21	9	0	25	5	0
r	20	11	0	31	0	0	15	16	2
ıber	9	21	7	1	29	2	2	28	4
ber	0	31	29	0	31	12	0	31	31
y.....	0	31	22	0	31	6	0	31	31
ıry	0	29	27	0	28	28	0	28	28
.....	0	31	29	0	31	31	0	31	31
.....	0	30	30	0	30	30	0	30	30
.....	0	31	29	0	31	31	0	31	20
.....	0	30	22	1	29	3	0	30	12
Year	38	328	224	68	297	148	81	284	189

Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1894.

Month.	Operating expenses.				Maintenance and repair.					
							Plant.			
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Labor.	Material.	Purchase and repair.	Hire.	Total.	Grand total.
1893.										
July	$893.33	$39.22	$94.20	$1,026.75	$406.00	$163.61	$181.94	.....	$751.55	$1,778.30
August	615.00	29.17	130.90	781.07	73.34	159.60	271.20	.....	504.14	1,285.21
September	680.00	29.16	108.77	817.93	227.00	198.00	124.35	.....	549.35	1,367.28
October	495.00	49.82	80.73	625.55	.....	954.98	7.93	.....	962.91	1,588.46
November	700.00	33.52	83.34	816.86	118.16	140.44	5.55	$35.00	299.15	1,116.01
December	600.00	29.16	29.26	658.42	117.04	33.83	21.87	3.00	175.74	834.16
1894.										
January	719.00	40.44	25.05	784.49	.....	54.00	.....	.....	54.00	838.49
February	560.00	113.65	32.94	706.59	.....	.....	63.80	.....	63.80	770.39
March	738.33	32.32	97.55	868.20	.....	307.86	.....	.....	307.86	1,176.06
April	617.66	35.91	22.40	675.97	32.40	32.19	.....	.....	64.59	740.56
May	706.00	40.87	53.03	799.90	182.72	25.99	.....	.....	208.71	1,008.61
June	506.00	31.07	80.00	617.07	37.00	565.54	.....	.....	602.54	1,219.61
Total	7,830.32	504.31	844.17	9,178.80	1,193.66	2,636.04	676.64	38.00	4,544.34	13,723.14

COMMERCIAL STATISTICS.

Commercial report for calendar year ending December 31, 1893.

Vessels.	Ascending.				Descending.				Total freight.
	Through lock.		Through pass.		Through lock.		Through pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	74	3,006	263	33,182	69	3,215	247	29,673	69,076
Towboats	248	.....	1,032	.....	237	.....	1,064	.....	.....
Model barges	14	.....	44	1,100	2	1,200	52	38,112	40,412
Coal boats	66	.....	210	.....	20	10,642	1,166	1,220,848	1,231,490
Barges	350	3,200	2,233	8,725	271	103,413	2,837	1,122,130	1,237,468
Flats	304	2,935	847	10,150	386	41,411	1,136	223,415	277,911
Rafts	1	25	.....	.....	15	4,623	65	235,432	240,080
Miscellaneous	27	.....	78	.....	61	.....	87	.....	.....
Total	1,084	9,166	4,707	53,157	1,061	164,504	6,654	2,869,610	3,096,437

D D 4.

MOVABLE DAM IN OHIO RIVER BELOW MOUTH OF BEAVER RIVER, PENNSYLVANIA.

The first appropriation for the work was made September 19, 1890 ($250,000), and by the river and harbor act of July 13, 1892, an additional amount of $100,000 was appropriated.

This dam, which is located 30 miles below Pittsburg, Pa., will be the sixth in the series of movable dams for improving the Ohio River by slack-water navigation. Davis Island Dam, located 4½ miles below Pittsburg, and which has been in successful operation since October, 1885, is the first of the series.

Active work of construction of the lock at this dam was resumed July 1, 1893, and continued until December 9, when work for the season was suspended.

The following is a summary of the work accomplished:

Excavation made	cubic yards..	12,214.7
Concrete laid	do.....	8,936.1
Ashlar masonry laid	do.....	3,059.8
Rubble masonry laid	do.....	2,387.4
Brick masonry laid	do.....	152.3
Concrete backing laid	do.....	1,403
Ironwork put in place	pounds..	201,187
Piling driven	linear feet..	702

The execution of this work completed about 80 per cent of the work of construction required for the river wall, drift chute, gate recesses and foundations, and about 34 per cent of that required for the land wall.

Borings were made in August, 1893, on the site of the dam across the entire width of river, to determine the character of the foundations. A bed of gravel from 30 to 40 feet in thickness was found to extend across the whole river.

The cofferdam has suffered but very little during the past year. The protecting cribs, which were injured somewhat in the spring freshets of 1893, have been repaired, raised in height 2 feet, and otherwise strengthened.

This work has been under the immediate supervision of Mr. William Martin, assistant engineer.

OPERATIONS DURING FISCAL YEAR.

[Extract from report of Mr. William Martin.]

At the beginning of the fiscal year work was progressing satisfactorily; our plant was in good condition, and the machinery—i. e., pumps, derricks, traveling crane, concrete mixer, etc.—working well.

The work projected for the season was the construction, so far as possible, of the lock walls, gate foundations and recesses, and the drift chute.

On July 1, 1893, 195 men were employed on the work, and as the season advanced this number was increased to 325 men on August 21. This was the largest number of men employed at one time during the year.

The months of July, August, September, October, and November were generally favorable for work. The river remained low, and nothing occurred during these five months to seriously interfere with the work. December set in cold and rainy, and the work progressed slowly. As fast as the work could be made safe and secure for the winter the force was reduced, and on December 9 the pumps were stopped and removed to a place of safety, and all work of construction ceased.

The following is a summary of work done during the year in permanent structures:

River wall of lock:

Concrete foundation	cubic yards..	3,840
Piling to protect foundation	linear feet..	702
Masonry, ashlar	cubic yards..	2,687
Masonry, concrete backing	do.....	1,058
Cast-iron valves and chambers (30 sets)	pounds..	149,306

This work cost $68,971.70, divided as follows: Labor, $26,518.07; material, $42,453.63.

Land wall of lock:

Excavation	cubic yards..	1,975.7
Concrete foundation	do.....	642.5
Masonry, ashlar	do.....	372.8
Masonry, concrete backing	do.....	345

This work cost $9,126.53, divided as follows: Labor, $4,111.34; material, $5,015.19.

Gate foundations:

Excavation	cubic yards..	4,379
Concrete	do.....	4,353.5
Iron bolts and disks (226)	pounds..	51,881

This work cost $17,695.51, divided as follows: Labor, $8,236.07; material, $9,459.44.

Gate recesses:

Excavation, rock	cubic yards..	2,000
Excavation, earth	do.....	2,500
Masonry, rubble	do.....	2,387.4

This work cost $20,960.29, divided as follows: Labor, $12,155.06; material, $8,805.23.

Drift chute:

Excavation	cubic yards..	1,360
Concrete foundation and backing	do.....	100.1
Brick masonry	do.....	152.3

This work cost $5,400.27, divided as follows: Labor, $4,290.52; material, $1,109.75.

Contract for stone.—Wilson Bros. & Co., of Ellwood City, Pa., the contractors for all classes of stone, whose contract is dated November 21, 1892, began the delivery of dimension stone July 24, 1893, and continued to supply the work with the various classes as demanded. The broken stone were supplied to the work in large or one-man size, and crushed at the work, the contractors having their crusher erected on the power-house foundation, being a convenient place for conveying the crushed stone to the concrete mixer. There has been delivered at the work 785 cubic yards of special, 2,675.2 cubic yards ashlar, 2,122 cubic yards of large rubble, and 4,829.4 cubic yards of broken stone. At the quarries, ready for delivery, there is 250 cubic yards special for coping and 500 cubic yards of ashlar.

By provisions of the contract the plain ashlar is cut at the quarry; all other forms are classed special, and are delivered at the work in the rough and cut by the United States. The stone is delivered by rail on a siding within reach of the yard derrick by which it is unloaded. The special stone is distributed to the cutters within the radius of the derrick. All the plain ashlar is loaded by the derrick onto a gravity incline car and run into the lock chamber, where it is unloaded by the traveling derrick and distributed to the proper locality.

Cement.—The principal brands of cement used are the Cumberland and Potomac and the Hoffman-Rosendale. The supply is received by rail and stored in a shed built adjacent to the railroad siding, and convenient for delivery to the concrete mixer and to the masons on the lock walls. The color and shade of each brand is taken account of, not for any purpose of testing, but for comparison with brands of other colors. The color of the Cumberland and Potomac is a "light cream," while that of the Hoffman-Rosendale is a "mouse color."

About fifteen samples from each car of cement received were tested; if any considerable variation below the standard required was noted, the shipper was immediately notified. All the cement of the brands noted was very uniform in fineness and strength.

Drift chute.—The drift chute connecting with the rear of the upper gate recess is designed to carry off to the lower pool all floating driftwood and débris which collects in the gate recesses and prevents the free operation of the gate. This part of the work is finished to within a few feet of each gate recess, lacking at the upper gate the connection of 21 feet to be completed. At the lower gate it is necessary to build 219 feet to extend it to a point in the lower guiding crib, a distance of 112 feet below the lower lock gate.

Excavation and foundations.—Excavations were made for the land wall, gate recesses, and gate foundations. In the lower depths of all these a kind of shale rock was encountered, which seemed to become more solid the deeper the excavation.

Exposure to the elements seemed to have a very marked disintegrating action upon the rock, especially upon the superficial strata, so that considerable depth of excavation had to be made into the rock to reach a satisfactory foundation.

Considerable difficulty was experienced in driving the sheet piling for the foundation of the river wall of the lock. The nature of the strata into which the piling was driven continued substantially the same throughout the whole length of the lock, consisting principally of large bowlders and compact gravel.

Borings.—Borings were made during the month of August on the site of the dam across the entire width of the river to determine the character of the foundation. Throughout the whole length of the dam, reaching from the lock to the opposite shore, there is a bed of 30 feet of gravel, increasing to a thickness of 40 feet on the south side of the river. On the north side, adjoining the lock, this gravel overlies a dark-colored shale, and at a few of the borings is intercepted by a layer of sand, from 3 to 6 feet in thickness, lying between the gravel and the shale. On the south side a layer of clay about 2 feet thick was noted, intercepting the gravel at a distance of from 36 to 39 feet below the surface.

Cofferdam.—The cofferdam, which was built in the fall of 1892, is still in apparent good condition, having suffered very little damage from ice and flood, yet, the lumber being chiefly of hemlock, there are evidences of decay which, though not serious at present, might in the course of a short time develop into very grave defects.

The protecting cribs, which are designed to secure the cofferdam against the action

ice and drift which pass down with the floods, suffered considerable damage he spring freshets of 1893. They have been rebuilt, and an addition of 2 feet o their height; they have also been sheeted and more securely anchored, and hese additional repairs have stood the floods of the season just past without gn of damage.

ping plant.—The pumping plant remains the same as last year, viz: One 1 and one 12-inch vertical centrifugal pump driven from a 14 by 16 inch hor- l engine. When pumping out the inclosure after a flood, both pumps are after the inclosure has been unwatered, one pump is sufficient.

ught-iron and steel derricks.—Believing that a change in the type of derricks nly used on works of this character would be advantageous and economical, gned a derrick composed of wrought-iron pipe, with fittings of cast steel. The nd boom are trussed with wrought-iron rods, making them perfectly rigid. ype of derrick has the advantage that the steel fittings can be used for a der- any height of mast or length of boom, possesses lightness, and is not subject ay and rot, as wooden derricks are. Four of this type of derrick were used on ork during the last season and gave highly satisfactory results. The cost ot exceed that of a wooden one, while its durability is without limit.

eling crane.—All the material excavated from the foundations of the lock walls e stone, sand, and other materials entering into the construction of the lock andled by a traveling crane running on a track of 16-foot gauge, laid in the hamber the entire length of the cofferdam inclosure, and parallel to the axis of k. This machine is of large capacity, capable of handling from 8 to 10 tons at a radius of 50 feet. In the items of time and labor the machine has saved to vernment several times its cost.

e work.—In addition to the routine office work the following special work has lone:

records of time on the various classes of work were kept with a view to deter- he actual cost of construction. The accounts are all reduced to a form that will uable as a basis of cost for work of a similar character.

wings of the completed work showing its present condition, plans for the cop- d special stones for use at the quarries and for the stonecutters on the work, of the changes made in the gate recess walls, omitting the lock filling and dis- ng valves and placing them in the river lock wall, also of the flushing con- and many other drawings of detail have been made.

Money statement.

, 1893, balance unexpended		$252,850.45
0, 1894, amount expended during fiscal year		173,706.01
, 1894, balance unexpended		79,144.44
, 1894, outstanding liabilities	$2,299.83	
, 1894, amount covered by uncompleted contracts	32,145.28	
		34,445.11
, 1894, balance available		44,699.33
unt (estimated) required for completion of existing project		550,000.00
unt that can be profitably expended in fiscal year ending June 30, 1896		200,000.00

nitted in compliance with requirements of sections 2 of river and rbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Commercial report for calendar year ending December 31, 1893.

Vessels.	Ascending.		Descending.	
	Number.	Freight.	Number.	Freight.
		Tons.		*Tons.*
	319	34,380	317	34,175
ts	863		860	
arges	58		54	51,300
ats	876		1,106	995,400
	580	1,500	3,108	1,653,456
	780	12,075	1,050	159,600
			59	177,000
otal	3,476	47,955	6,554	3,070,931

D D 5.

ICE HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations for the work:

March 3, 1879	$30,000
June 14, 1880	50,000
March 3, 1881	30,000
August 2, 1882	40,000
July 5, 1884	50,000
August 5, 1886	37,500
August 11, 1888	60,000
September 19, 1890	30,000
Total	327,500

The ice harbor is the lower pool of the Muskingum River, which has been created by the slack-water dam at Marietta, and the object of the work under consideration is to build a passway through this dam of such size as will permit Ohio River packets and coal fleets to take refuge from ice in this pool. The passway in question consists of a large lock, which, owing to the local conditions controlling the only available site, was built with independent axes of entrance and exit, the angle between these axes being 11° 15′. This construction involved the necessity of widening the lock chamber at both ends so as to permit boats to change direction while in the lock. The plan of the lock chamber is therefore somewhat like an hourglass, the lock being narrowest in the middle. The maximum rectangle which can be passed through the lock has a length of 365 feet and a width of 56 feet. The work has been in progress since 1880, but has been kept back by inadequate appropriations and the occasional absence of any appropriation. The lock is now nearly finished and is in use, but requires some additional work in providing machinery for operating the gates and finishing a small amount of masonry. Middle gates should be provided for more rapid operating in passing the boats that use the lock most. A lockkeeper's dwelling should be built, and the grounds about the lock, which belong to the city of Marietta and have been used by the United States for a number of years without cost, should be placed in presentable order, all of which will cost about $10,000. In the last annual report is shown the necessity for the appropriation of this amount ($10,000) in order to place the lock in good condition. Its appropriation is therefore again respectfully recommended.

There being but a few dollars available, no work has been done during the year.

The question relating to the changing of the bridge belonging to the Baltimore and Ohio Southwestern Railroad Company should be settled in some way, in order that the lock might be entered by the Ohio River boats and the pool above utilized as an ice harbor, in accordance with the purpose for which the lock was built. The bridge as it now stands, crossing the Muskingum River just below the lock, has a draw on the side of the river opposite to the lock, the side where the old lock was located. The railroad company have declined to place a second draw in their bridge for passage into the new lock, arguing that it should be done by the United States, on account of the United States having changed the channel way from the side of the river where they had provided a draw. In the river and harbor bill now pending a provision has been inserted looking to the settlement of this matter.

mmercial statistics are attached to the report for operating and of locks and dams on the Muskingum River.

OPERATIONS FOR THE FISCAL YEAR.

[Extract from report of Mr. Edmund Moeser.]

appropriation of September 19, 1890, being practically exhausted, there were penditures for construction during the year. The lock, though incomplete, een successfully operated during the year; it will, however, not be available io River packets and coal fleets seeking refuge from ice in the lower pool of the ingum River until a draw is placed in the railroad bridge just below it.

Money statement.

, 1893, balance unexpended	$40.68
30, 1894, amount expended during fiscal year	10.00
., 1894, balance unexpended	30.68
ount (estimated) required for completion of existing project	10,000.00
ount that can be profitably expended in fiscal year ending June 30, 1896	10,000.00

mitted in compliance with requirements of sections 2 of river and arbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

D D 6.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

LOCKS AT ZANESVILLE AND TAYLORSVILLE.

e lock at Taylorsville is now practically completed, with the excep- of machinery for operating the gates, but this lock can not be e available until a draw is placed in the county bridge just below The commissioners of Muskingum County, to whom the bridge ngs, were ordered to change it, but thus far have not done so. A ision has been inserted in the pending river and harbor bill look- o a settlement of this matter.

ith regard to the reconstruction of the lock at Zanesville, drawings been made of a proposed plan of reconstruction and estimates of made, but are held for further consideration. The existing locks e kept in operation for some time yet without costly repairs.

is work has been under the immediate supervision of Mr. Edmund er, assistant engineer.

OPERATIONS FOR THE FISCAL YEAR.

[Extract from report of Mr. Edmund Moeser.]

s work is carried on under the appropriation of August 11, 1888, for the con- ion of a lock at Taylorsville and the reconstruction of the lock at Zanesville,

re was no work of construction in operation under this appropriation during ar.

the new lock at Taylorsville can not be used until a draw is placed in the rsville and Duncans Falls bridge, it was thought unadvisable to make gate ting machines or build a guiding crib above the lock, the work yet to be done nplete it, until they are needed for use.

lan was prepared showing in detail the proposed work under that part of the priation relating to the reconstruction of the lock at Zanesville.

mmercial statistics are attached to the report for operating and care of locks ams on Muskingum River.

Money statement.

l. 1893, balance unexpended	$13,754.57
l, 1894, *balance unexpended*	13,754.57

D D 7.

OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations and allotments for this work:

August 5, 1886 (appropriated)	$20,000.00
July 21, 1887 (allotted)	190,000.00
August 13, 1888 (allotted)	177,623.00
July 1, 1889 (allotted)	232,080.00
July 19, 1890 (allotted)	195,665.00
May 28, 1891 (allotted)	20,000.00
July 8, 1891 (allotted)	155,200.00
November 9, 1891 (allotted)	39,980.00
November 24, 1891 (allotted)	1,200.00
December 9, 1891 (allotted)	1,200.00
January 5, 1892 (allotted)	12,241.54
August 3, 1892 (allotted)	42,919.47
July 22, 1893 (allotted)	52,745.36
Total	1,140,854.37

As originally improved by the State of Ohio, 11 dams and 12 locks were built on the Muskingum River, furnishing continuous navigation for 91 miles from the Ohio River at Marietta to Dresden, where a connection was made with the Ohio Canal near its middle point, this canal extending from the Ohio River at Portsmouth to Lake Erie at Cleveland. According to old reports from the State board of public works, the locks were built with a length between hollow quoins of 180 feet and a clear width of 36 feet, except the upper lock between Zanesville and Dresden, which had a length of 120 feet and a clear width of 22 feet. The lifts as reported varied from 8 feet 10 inches to 12 feet 1 inch, but measurements made since the United States took charge show that none of the above dimensions were strictly accurate. The work cost the State of Ohio about $1,500,000. The lock and dam above Zanesville is now in a state of ruin, but the 75 miles of slack water between the Ohio River and Zanesville have always been maintained; on this piece of river there are 10 dams, 11 locks, and 5 lateral canals with a total length of 3⅜ miles.

The locks and dams were about worn out when they passed into the hands of the United States, in April, 1887, and a general reconstruction was unavoidable. This work was very greatly retarded and cost of reconstruction much increased by the extraordinary rainfalls during the progress of the work in 1890. As stated in report of last year, the floods of 1893 did a great deal of damage to the older portions of the structures, necessitating the rebuilding of 110 feet of Dam No. 2, at Devols, and 103 feet and abutment at Dam No. 6, Stockport, and extensive repairs to Dam No. 9, at Taylorsville, and No. 10, at Zanesville. To prevent further washing of the banks and repair damage already done, spur dikes were constructed at Dams Nos. 2, 4, 5, 6, 7, and 8. In some places, also, stone revetments were laid. The effect of the dikes has already been very beneficial. Good navigable depth has been maintained, and during the past season the works have suffered but little, if any, damage. There was no interruption to navigation by failure of any of the structures. During the winter, ice in the canals caused a few days' suspension. All the repairs contemplated for the year were completed and incidental repairs made as required. From time to time it will be necessary, in the near future, to repair or replace certain portions of the old work, especially dams, as they become dan-

gerous, and a portion of Dam No. 6, which shows signs of weakness, should be replaced during the coming year.

This work has been under the immediate supervision of Mr. Edmund Moeser, assistant engineer.

It having been decided by the Secretary of War, upon the recommendation of the Chief of Engineers, that no funds could be supplied from the indefinite appropriation for operating and care of canals and other works of navigation for any work whatever except for actual cost of operating and care, there are no funds available for any betterment of the works, or for needful additions. There are lock-keepers' dwellings at five of the locks, but none at five of the locks. Certain improvements, such as additional guide cribs at entrance of locks, would be of material benefit to navigation. In order to provide for such work, I would earnestly recommend that the amounts received by the Government for rental of lands and water power along the river, which is now turned into the Treasury by the officer in charge of the work, should be deposited to that officer's credit and be made available for such work of improvement on the river. The amount collected each year is not large; this year it was $3,234.56.

OPERATIONS DURING THE FISCAL YEAR.

[Extract from report of Mr. Edmund Moeser.]

All work of repairs as proposed in the approved project for the year, together with such incidental repairs as were essential for the maintenance of navigation and protection of existing works, was completed.

There was no suspension of navigation on account of failure of any of the structures, and, with the exception of a few days during the past winter when the canals were frozen over, there was no obstruction by ice.

The river is in excellent condition at the close of the year, with no material damage to any of the structures by floods or ice to be reported. This fact is worthy of note as showing the permanency of the improvements made by the General Government.

A full utilization of the Muskingum River improvements can only be secured by an interchange of traffic on the Ohio and Muskingum rivers. This would be effected if the present fixed channel span of the railroad bridge below Lock No. 1 were replaced by a draw. The Muskingum River would then be available to craft navigating the Upper Ohio, and the object for which Lock No. 1 was built, a passway through the dam for Ohio River boats seeking refuge from ice, be attained.

The following is a detailed statement of the work done during the past year:

LOCKS AND DAMS.

Lock and Dam No. 1, Marietta.—Repairs were made to the lock walls. Two large cracks in the masonry at upper end of lock were filled with cement mortar. Cavities on face of river wall, caused by the disintegration of the stone, were cleaned and filled with concrete, and all open joints on both walls were repointed. Vitreous tile water-gauges were placed on walls at upper and lower end of lock. The upper lock gates were repaired by inserting new timbers to replace decayed pieces on top and along toe of both gates. Nine ringbolts, for use in locking barges and rafts, were fastened on chamber faces of walls. To stop leaks around lower end of land wall of lock, the dry wall between mill race and lock was raised 5 feet for a distance of 35 feet, and the area between this wall and the lock was filled with tight material. The lock gates, lock irons, and turbine machines were repainted.

There was taken from the grounds about the lock and shipped to points along the river, where required, 104,457 feet of timber, 2,880 pounds of driftbolts, and 1,508 feet of piling,

In order to make the crossing below dam, from lock on left side to draw, in bridge just below the lock, on right side of river, more safe, 22 piles, in addition to those already in place, were driven just above the bridge and in approaches to old draw-span.

No work was done to the dam, as nothing was necessary.

Lock and Dam No. 2, Devols.—The crib extension of the right abutment of dam was refilled with stone and decayed portions of timber in crib were renewed. The downstream slope of embankment connecting the abutment with high ground was covered with a layer of stone 18 inches deep, to protect embankment from action of eddy below dam.

Repairs made to lock walls consisted in dressing back, flush with chamber face of walls, 76 feet of the old coping on river wall, stopping two large leaks through land wall with concrete filling, and concreting and pointing 585 square feet of face of wall. The floods of May, 1893, tore out the crest of the dam at the right abutment for a distance of 110 feet; on account of the continued high water the extent of this damage was not ascertained until after the beginning of the fiscal year. As soon as approval was received and the water had reached a sufficiently low stage, the crest was replaced and a backing of stone and gravel placed along the entire length of new work.

A spur dike 88 feet long was built on the right bank, 150 feet below the abutment.

Lock and Dam No. 3, Lowell.—Operations were for rebuilding the guide crib below river wall of lock, 35 feet in length, the retaining wall below land wall, 40 feet in length, and for refilling the terreplein and bank immediately below lock to a level with top of lock. Contingent work was for a row of guide piles below land wall of lock and minor repairs to sheeting of dam.

Lock and Dam No. 4, Beverly.—The guide crib below river wall of lock, 25 feet in length, was rebuilt from low-water level to a height of 5 feet below top of lock wall.

The retaining wall above right abutment of guard gates, 40 feet long, which had collapsed, was rebuilt.

The top of the spill dam at head of canal was resheeted for its entire length of 170 feet, and the sheeting on second step was renewed for a distance of 85 feet. A gap in the brush and stone extension of the right abutment of dam was closed with 497 feet of piling, 110 cords of brush, and 250 cubic yards of stone. A small amount of brush and stone was filled along the toe of the embankment at right abutment where there was evidence of scour.

A spur dike 570 feet long was built on a line parallel with the dam and 800 feet below the right abutment; although but lately finished, it is evident from the amount of fill which has already taken place over the washed-out area below the abutment that the contemplated protection to embankment and land back of abutment is assured by this dike.

The mill race back of the lock was drained and the culvert at head of race was cleaned of the brush and mud lodged in it.

The storehouse and lock gates were repainted and the grounds about lock kept in first-class condition.

Lock and Dam No. 5, Luke Chute.—The decayed and worthless guide crib above river wall of lock was rebuilt; length of crib, 70 feet. The remainder of the crib below the river wall, 25 feet long, was torn out and a new crib built.

A number of leaks through the old masonry of lock walls were stopped by filling in concrete, and 1,235 square feet of the chamber face of river wall was repaired with concrete. The corners of lower gate recesses were rounded and four new iron ladders were inserted in recesses on walls.

The embankment at right abutment of dam was refilled to a uniform level, and the collapsed paving on downstream slope taken up and reset.

The terreplein of lock was cleaned of old buildings and rubbish and refilled to a level with top of lock.

Minor repairs were made to the roof and floors of the lock-keeper's house, and the house and fence around part of lock lot were repainted.

Two low spur dikes, one below lock and one below abutment of dam, were constructed. They are 123 and 160 feet long, respectively.

Lock and Dam No. 6, Stockport.—Expenditures during the year have been applied to rebuilding a section of dam 103 feet in length, one abutment 53 feet long, a spur dike 115 feet in length, and to refilling lot back of lock, and placing a temporary timber structure on foundation of guiding crib below lock.

At the close of the last fiscal year a brush and stone coffer had been placed around the break in the dam and collapsed abutment and navigation through the lock had been restored. Active operations for rebuilding the destroyed section of dam and abutment were commenced on August 1, and the work was completed September 30, 1893. The dam was repaired by building a section of slope dam similar to the new portion of dam next the lock. Although the great depth of water, 17 feet at normal level of lower pool, caused some delay in the work no great difficulty was experienced in sinking the timbers to place. The cribs were well filled with stone, most of which was taken from the coffer as the work progressed. The coffer also furnished excellent material for backing the dam, which work was done in a very thorough manner. One hundred and eighty cubic yards of large-dimension stone was placed along front of dam where the greatest depth of water was found.

The few lower courses of masonry remaining in place when the abutment failed were found to be worthless, being nothing more than an outside shell of stone filled with spalls, clay, and lime mortar. They were therefore torn out and an entire new abutment founded on bed rock was built. The amount of masonry in abutment is 492 cubic yards, placed at a cost of $4.78 per cubic yard.

A fill of 150 cubic yards of earth was made back of the land wall of lock, and the lock yard was graded.

A stone spur dike for protection of banks below the left abutment of dam was completed.

Lock and Dam No. 7, McConnelsville.—The terreplein and banks around lock were refilled, graded, and sown in grass. A large washout in canal bank just below the dam, which threatened to become disastrous to the canal, was refilled with clay and faced with stone. A spur dike, to break eddy and protect the bank at this place from further erosion, was completed. The dike is built at right angles to the current, beginning on top of the bank and running out level for a distance of 40 feet; thence on a slope of 1 on 3 for a distance of 80 feet to the bed of the river. The structure was built with an interior filling of spalls and gravel, covered with 2 feet of rubble stone and 18 inches of paving stone.

The embankment back of the left abutment of dam was repaired with a stone and gravel fill along toe of embankment and in front of old head gates to abandoned mill race through embankment.

A dry wall, 60 feet in length, was built at lower end of lock to retain earth fill back of land wall.

The stems of both cylindrical filling valves of lock became detached from valves during the past winter. Repairs were promptly made, and there was no delay in the use of the lock on this account.

New anchorage irons for guard gates at head of canal were put in place.

At the Government boat and store yard the storehouses, carpenter shop, and all buildings connected with store yard were repainted. The timbers for new guard gates at No. 9 were dressed, 2 barges were extensively repaired, 1 dump scow calked, fender planking for gates prepared, and all lock poles required during the year made.

Lock and Dam No. 8, Eagleport.—The embankment back of the abutment of dam, which was almost destroyed by the floods of 1893, was refilled with 1,451 cubic yards of clay and covered with 400 cubic yards of paving stone. To retain the toe of this embankment, a crib extension to the abutment, 35 feet long, was built, and a row of close piling driven along front of fill. Owing to depth of water and sandy nature of bottom around lower end of abutment, the crib, which is 25 feet in height, was built on piling. The work done to embankment is now very substantial, and no anxiety is felt with regard to a break around the abutment during flood stages.

Additional protection to the bank is assured by the spur dike built below the abutment. This dike is 166 feet long, the outer end being in 24 feet of water at normal level of pool.

To stop leak between lower miter sill and lower gates of lock, an iron filling piece was fastened to timber cushion of sill. Repairs were made to old portion of river wall of lock; the disintegrated stone on chamber face of wall was cut back to cavities in wall, concrete was then packed in, and a good finish given to face. After the openings on face of wall had all been closed, the cavities in interior were filled with grout through holes drilled down from top of wall. The work has resulted in almost an entire stoppage of the large leaks through this wall.

The lock keeper's house was moved a distance of 200 feet to high ground on lock lot, overhauled, and placed in first-class condition.

The terreplein of lock was refilled with earth, and the entire lock yard was graded and sown in grass. The cross crib at lower end of lock was refilled with stone, short guide cribs were built above both lock walls, and guiding piles were driven in both approaches to lock.

Lock and Dam No. 9, Taylorsville.—New guard gates to replace old and decayed ones were built and placed in position at head of canal.

The gates at old Lock No. 9 were overhauled and again made serviceable. The repairs consisted in placing 2 new arms on top of each of the 4 gates, new blocks in all of the spaces between arms from below water line to top of gates, new sheeting on 2 gates, and additional iron brace bars on all 4 gates.

Early in the season a brush and stone cofier was thrown around the section of dam damaged during the preceding winter. One hundred feet of the crest was then rebuilt, 98 feet of top sheeting replaced, and 81 feet of the longitudinal timbers and sheeting of the second step were renewed.

Minor repairs were made to guard gates, abutments, operating machines of lock gates, and storehouse.

The walls at lower recesses of old lock were dressed back so that the gates can be opened back full depths of gate recesses, and thus increase available width of chamber.

Lock and Dam No. 10, Zanesville.—A new piece of coping, to replace worn stone, was laid at upper end of land wall; the middle miter sill wall of combined lock was filled with concrete to stop leaks. The timber sill, which had raised, was forced back into place, fastened, and spaces between timbers filled with concrete.

The two guiding cribs above lock, each 35 feet in length, were rebuilt. The damage to canal banks caused by floods of 1893, was repaired by making an earth fill on top of banks over a distance of 600 feet. New upper gates for the lock, built during the previous year, were hung. Extensive repairs to the dam were necessary. A coffer 35 feet long was placed, and a break in crest repaired; a crib 43 feet long, at left end of dam, was rebuilt, and the sheeting on second step was renewed for a distance of 108 feet.

BOATS.

The dredge *Malta* has done good work during the past year. This is shown by the present available depth of water in canals and on shoals in open river, which is without doubt the best known in the history of the Muskingum improvements.

The chamber of Lock No. 1, approaches to Locks Nos. 2, 3, 7, 8, 9, and 10, canals at Beverly, Lowell, McConnelsville, and Taylorsville, and channels in pools Nos. 2, 6, and 7 were dredged. During the low-water season the dams at Nos. 3, 4, 6, 7, and 9 were backed with spoils taken from channels. The remains of several boat hulls were removed from the river, and a large number of stones, snags, and logs were taken out.

The towing for the dredge during the season of 1893 was done by the hired steamboat *Lizzie Cassel*.

Repairs were made to the dredge while in winter quarters at Zanesville.

The Government steamer *Vega* was engaged in transporting the large amount of materials required for repairs to locks and dams, and material used in construction of spur dikes.

The floating pile driver has been kept in good repair, and was used for driving the piling for 4 spur dikes, and the guiding piles at Marietta, Lowell, and Eagleport. The services of the driver were also required for loading on barges the 270 cubic yards of large stone used in substructure of dike at No. 8.

BRIDGES.

Railroad bridge of the Baltimore and Ohio Southwestern Railroad Company at Marietta, Ohio.—Nothing has yet been done toward altering this bridge. The Secretary of War authorized the placing of piles under the channel span of this bridge, provided it would not interfere with navigation. The railroad company has placed these piles as directed and as agreed upon by the steamboat men interested in navigation at this point.

Beverly and Waterford bridge.—The foundation of the old rest pier in the right-hand draw space was removed by the commissioners of Washington County. The foundation in left hand space having been previously removed, both spaces of the draw are now available for navigation.

Bridge across canal at Beverly.—This bridge was removed by the owner, there being no further use for it. The crib pivot pier, rest pier, and timber approaches were torn out, thereby increasing the available width of canal.

Taylorsville and Duncan's Falls bridge.—Nothing has been done toward altering this bridge.

Main street bridge at Zanesville.—Nothing has been done toward altering this bridge.

Old Fifth street bridge at Zanesville.—The superstructure was removed and the piers torn out to a depth of about 3 feet below normal level of pool. An application for further extension of time in which to remove the remainder of foundations of old piers having been made by the commissioners of Muskingum County, the time for removal of the piers was extended by the Secretary of War to September 1, 1894.

LAND.

The Zanesville and Ohio River Railroad, through a mistake as to ownership, runs without authority across the Government land at No. 7, Malta, Ohio; no effort to obtain the right of way from the United States has as yet been made.

A revocable lease was issued to Sarah V. Plummer for 1.10 acres of land at No. 11, Symmes Creek, and to R. W. Huff for 3.50 acres at No. 9, Philo, Ohio.

Muskingum River leases.

YEAR ENDING APRIL 30, 1894.

Location.	Lessee.	Dated.	Expires.
Dam No. 1, Marietta	Phœnix Mill Co	May 1, 1873	May 1, 1903
Dam No. 2, Devols	Gates & Payne	May 1, 1889	May 1, 1909
Dam No. 3, Lowell	Milton King	May 1, 1890	May 1, 1910
Do	F. Wilking & Co	....do	Do.
Do	Rechsteiner Bros	....do	Do.
Do	.....do	Nov. 1, 1892	Nov. 1, 1912
Do	E. W. Sprague	Dec. 2, 1879	Dec. 15, 1909
Do	George Rice	Sept. 1, 1889	Sept. 1, 1909
Dam No. 4, Beverly	Robbins Bros	May 1, 1889	May 1, 1909
Do	Stull & Jumper	May 3, 1889	May 3, 1909
Do	George S. Worstell	May 1, 1890	May 1, 1910
Do	Mary L. Baldwin	....do	Do.
Do	D. T. Brown	....do	Do.
Do	Isaac D. Spooner	....do	Do.
Dam No. 6, Stockport	Joseph Newberry	May 1, 1889	May 1, 1909
Dam No. 7, McConnelsville	E. M. Stanberry	Sept.—, 1839	
Dam No. 9, Duncans Falls	John Miller	Dec. 31, 1836	
Dam No. 9, Taylorsville	Frazier & Son	....do	
Dam No. 10, Zanesville	John T. Drone	May 1, 1890	May 1, 1910
Do	Edward Johnson	....do	Do.
Do	.....do	May 1, 1889	May 1, 1909
Do	Muskingum Coffin Co	May 1, 1890	May 1, 1910
Do	Gary & McLaughlin	....do	Do.
Do	T. L. Moorehead	May 1, 1893	May 1, 1913
Symmes Creek	Sarah V. Plummer	April 2, 1889	Apr. 2, 1894

YEAR ENDING MAY 31, 1894.

Dam No. 10, Zanesville	John Blankenbuhler	June 1, 1892	June 1, 1909
Do	Frederick Abel	....do	Do.

Leases—Water power, land, and rental.

Lessee.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate.	Rents collected.
Phœnix Mill Co	Water power	3,000	$350.00	$71.06	$278.94
Gates & Payne	....do	9,000	108.00		108.00
Milton King*	....do	2,600	100.00		
F. Wilking & Co	....do	7,280	174.72		174.72
Rechsteiner Bros	....do	4,446	106.70		106.70
Do	Land		10.00		10.00
E. W. Sprague	....do		5.00		5.00
George Rice	....do		6.00		6.00
Robbins Bros.†	Water power	1,904	100.00		
Stull & Jumper‡	....do	5,500	132.00		
George S. Worstell	....do	5,600	114.24		114.24
Mary L. Baldwin	....do	5,000	100.00		100.00
D. T. Brown	....do	6,500	118.30		118.30
Isaac D. Spooner	....do	4,000	100.00		100.00
Joseph Newberry	....do	6,390	230.04	80.86	149.18
E. M. Stanberry§	....do	(‖)			
John Miller§	....do	(¶)			
Frazier & Son§	....do	(¶)			
John T. Drone	....do	7,560	453.60		453.60
Edward Johnson	....do	6,029	361.74		361.74
Do	....do	7,399	443.82		443.82
Muskingum Coffin Co	....do	4,619	207.86		207.86
Gary & McLaughlin	....do	4,794	186.97		186.96
T. L. Moorehead	Land		25.00		25.00
Sarah V. Plummer**	....do				
John Blankenbuhler	Water power	2,700	100.00		100.00
Frederick Abel	....do	5,200	184.50		184.50
Total					3,234.56

* Lessee insolvent; water shut off.
† No collection.
‡ Lease canceled Apr. 26, 1894.
§ Perpetual free lease of water power.
‖ Enough to propel 10 run of 4 foot 5 inch millstones.
¶ Enough to propel 15 run of 4½-foot millstones.
** Terms five years in advance.

Detailed statement of expenses incurred on Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1894.

GENERAL ADMINISTRATION.

Month.	Salaries.		Plant.						
	Office force.	Lock-keepers, bridge-tender, gauge-reader, and watchman.	First cost.	Repairs.	Repair of buildings.	Supplies.	Transportation.	Miscellaneous.	Total.
July	$330.00	$849.00	$27.42	$32.25	$10.00	$33.02	$35.49	$60.38	$1,177.56
August	455.00	729.00	14.32	34.30	.....	19.97	11.32	46.28	1,310.19
September	430.00	729.00	18.73	2.50	295.61	60.32	3.00	53.99	1,593.15
October	430.00	627.00	21.30	.60	113.64	37.95	3.50	69.33	1,303.32
November	455.00	649.00	15.04	2.70	15.70	20.17	11.39	51.19	1,220.19
December	430.00	649.00	.80	.75	7.05	8.72	21.63	94.22	1,212.17
January	430.00	649.00	.33	.....	.....	6.73	.....	37.53	1,123.59
February	455.00	649.00	.....	.....	.....	28.28	6.50	27.43	1,166.21
March	580.00	649.00	7.50	.....	.....	3.10	.....	29.73	1,269.33
April	430.00	649.00	1.50	1.77	92.13	6.85	.30	43.01	1,224.56
May	555.00	649.00	2.00	70.80	71.63	6.70	.....	49.09	1,404.22
June	500.00	649.00	101.50	19.02	.....	1.73	.....	81.24	1,352.49
Total	5,480.00	7,926.00	210.44	164.69	605.76	233.54	93.13	643.42	15,356.98

UNITED STATES DREDGE MALTA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Towboat.	Total.
July	$565.98	.....	$28.90	$54.95	$384.00	$1,033.83
August	581.36	$59.65	136.13	4.46	648.00	1,429.60
September	507.68	.....	30.00	2.99	624.00	1,164.67
October	510.68	9.75	65.20	173.07	552.00	1,310.70
November	557.66	17.68	38.23	32.88	624.00	1,270.45
December	462.00	.....	10.00	99.50	192.00	763.50
January	116.00	1.75	.....	67.69	.....	185.44
February	53.33	.....	.....	7.45	.....	60.78
March	5.00	.....	.....	265.86	.....	270.86
April	228.50	.....	3.15	128.69	.....	360.34
May	369.84	9.00	21.68	25.73	115.00	541.25
June	490.16	57.14	145.81	.....	598.00	1,291.11
Total	4,448.19	154.97	479.10	863.27	3,737.00	9,682.53

UNITED STATES STEAMER VEGA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Total.
July	$401.36	$1.25	$39.00	$19.38	$461.00
August	357.50	1.00	31.53	.....	390.03
September	360.38	31.43	49.93	.....	441.74
October	357.50	.....	21.58	23.65	402.73
November	360.38	.....	39.49	.....	399.87
December	307.92	14.42	23.45	.....	345.79
January	66.00	.....	53.01	.....	119.01
February	80.40	.....	2.42	.....	82.82
March	147.86	.....	90.83	.....	238.69
April	140.42	20.74	15.73	.....	176.89
May	351.50	.....	18.25	2.20	371.95
June	360.38	.....	22.33	.....	382.71
Total	3,291.60	68.84	407.64	45.23	3,813.31

Detailed statement of expenses incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 1.

Month.	Labor.	Material.	Supplies.	Total.
July	$2.00			$2.00
August	27.00			27.00
September	19.20	$14.87		34.07
November	37.05	6.00		43.95
December			$7.53	7.53
April	41.24			41.24
June	156.60	39.94		196.54
Total	283.99	60.81	7.53	352.33

LOCK AND DAM NO. 2.

July	$4.32			$4.32
August	5.76	$5.22		10.98
September	151.20			151.20
October	193.94	262.88	$3.38	460.20
November	19.28			19.28
April	70.00			70.00
June	7.20			7.20
Total	451.70	268.10	3.38	723.18

LOCK AND DAM NO. 3.

July		$19.85	$0.95	$20.80
August	$1.80		.45	2.25
September	12.73		.45	13.18
October	122.36	94.33	3.38	220.07
November	158.64	122.77		281.41
December	8.64			8.64
May	22.06		.56	22.62
Total	326.23	236.95	5.79	568.97

LOCK AND DAM NO. 4.

July	$7.74		$0.45	$8.19
August		$18.48		18.48
September	177.57	1.50		179.07
October	155.59	106.98	3.38	265.95
November	366.12	218.72		584.84
December	14.04	79.68	4.00	97.72
February	6.12			6.12
May	12.84	16.92		29.76
June	103.60	961.45		1,068.05
Total	846.62	1,403.73	7.83	2,258.18

LOCK AND DAM NO. 5.

August	$53.46			$53.46
September	58.86			58.86
October	27.24			27.24
November	205.40	$245.54		450.94
December	5.04	80.88		85.92
January		927.46		927.46
April	50.76	44.94		95.70
May	415.44	23.08		468.52
June	231.12	2.02		233.14
Total	1,077.32	1,323.93		2,401.24

Detailed statement of expenses incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 6.

Month.	Labor.	Material.	Supplies	Total.
July	$578.16	$151.82	$15.00	$744.98
August	1,565.34	1,004.71	24.00	2,594.05
September	1,366.64	2,077.57	40.00	3,484.21
October	273.46	13.40	13.88	300.74
November	110.46	410.50	.....	520.96
December	15.66	52.75	.....	68.41
January	.....	.....	3.32	3.32
May	3.96	.....	.....	3.96
June	190.80	4.60	.....	195.40
Total	4,104.48	3,715.35	96.20	7,916.03

LOCK AND DAM NO. 7.

July	$14.40	$17.38	.....	$31.78
August	164.13	.....	$4.38	168.51
September	296.45	85.27	.....	381.72
October	454.30	50.85	2.25	507.40
November	68.29	.....	.....	68.29
December	23.76	6.00	.....	29.76
February	11.52	.....	1.25	12.77
March	100.15	.....	.....	100.15
April	261.03	.....	3.15	264.18
May	128.76	.40	.....	129.16
June	291.26	14.92	.....	306.18
Total	1,814.05	174.82	11.03	1,999.90

LOCK AND DAM NO. 8.

July	$7.20	$26.79	$0.75	$34.74
August	1,216.94	18.72	3.32	1,238.98
September	523.08	49.90	.....	572.98
October	335.86	607.23	.....	943.09
November	76.88	.....	.....	76.88
December	152.05	79.68	.....	231.73
February	4.32	.....	.....	4.32
April	49.52	5.50	3.15	58.17
May	364.77	72.15	.....	436.92
June	130.52	74.97	.....	205.49
Total	2,861.14	934.94	7.22	3,803.30

LOCK AND DAM NO. 9.

July	$14.08	.....	$1.00	$15.08
August	691.68	$625.22	5.00	1,321.90
September	217.34	151.86	.....	369.20
October	285.18	16.83	.....	302.01
November	158.43	243.41	.....	401.84
December	146.42	39.81	.....	186.23
January	.....	.....	3.24	3.24
May	46.98	15.15	.....	62.13
June	59.28	.....	.....	59.28
Total	1,619.39	1,092.28	9.24	2,720.91

Detailed statement of expenses incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 10.

Month.	Labor.	Material.	Supplies.	Total.
July	$20.22	$46.18	.....	$66.40
August	577.19	361.07	.....	938.26
September	327.39	22.49	$4.51	354.39
October	151.50	20.82	3.51	175.83
November	66.78	6.14	2.65	75.57
December	20.96	.70	.....	21.66
January	.....	.....	3.06	3.06
February	6.48	.....	.....	6.48
March	25.56	.....	.....	25.56
April	37.56	.....	3.15	40.71
May	7.56	.....	.....	7.56
June	7.38	1.01	.....	8.39
Total	1,248.58	458.41	16.98	1,723.87

SUMMARY.

General administration	$15,356.98	Lock and Dam No. 6	$7,916.03
U. S. dredge *Malta*	9,682.53	Lock and Dam No. 7	1,990.90
U. S. S. *Vega*	3,813.31	Lock and Dam No. 8	3,803.30
Lock and Dam No. 1	352.33	Lock and Dam No. 9	3,720.91
Lock and Dam No. 2	723.18	Lock and Dam No. 10	1,723.87
Lock and Dam No. 3	568.97		
Lock and Dam No. 4	2,258.18	Total	53,320.73
Lock and Dam No. 5	2,401.24		

Detailed statement and cost of dredging on the Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1894.

Date.	Locality.	Materials excavated.	Total cost.
July	Taylorsville, Ohio	10,794½ yards gravel, sand, and mud, at 9 cents.	$971.52
	do	5 snags, at $6	30.00
	do	17 stones, at $1.90	32.30
August	do	13,210 yards gravel, sand, and mud, at 9 cents.	1,188.90
	Lowell, Ohio	400 yards gravel, sand, and mud, at 9 cents	36.00
	Devols Dam, Ohio	1,411½ yards gravel, sand, and mud, at 14½ cents.	204.70
September	do	7,300 yards gravel, sand, and mud, at 15 cents.	1,095.00
	do	3 snags, at $7.50	21.00
	do	68 logs, at 50 cents	34.00
	do	1 boat gunwale	14.67
October	do	1,850 yards gravel, sand, and mud, at 9 cents.	166.50
	Marietta, Ohio	11,700 yards gravel, sand, and mud, at 9 cents.	1,053.00
	Lowell, Ohio	1,013½ yards gravel, sand, and mud, at 9 cents.	91.20
November	do	3,570 yards gravel, sand, and mud, at 12 cents.	428.40
	Beverly, Ohio	2,111 yards gravel, sand, and mud, at 12 cents.	253.32
	Stockport, Ohio	2,100 yards gravel, sand, and mud, at 12 cents.	252.00
	McConnelsville, Ohio	2,803 yards gravel, sand, and mud, at 12 cents.	336.72
December	Eagleport, Ohio	2,900 yards gravel, sand, and mud, at 15 cents.	435.00
	do	6 logs, at $1	6.00
	do	1 snag	7.52
	Taylorsville, Ohio	1,750 yards gravel, sand, and mud, at 18 cents.	315.00
January	.....	Repairs on dredge	185.44
February	.....	do	60.78
March	.....	do	270.86
April	.....	do	360.34
May	.....	do	320.45
	Zanesville, Ohio	360 yards gravel, sand, and mud, at 16 cents.	57.60
	Taylorsville, Ohio	1,260 yards gravel, sand, and mud, at 12 cents.	151.20
	do	2 snags, at $6	12.00
June	do	4,600 yards gravel, sand, and mud, at 7 cents.	322.00
	Eagleport, Ohio	5,000 yards gravel, sand, and mud, at 7 cents.	350.00
	do	3 snags, at $2.50	7.50
	McConnelsville, Ohio	200 yards sand and mud, at 10 cents	20.00
	Devols Dam, Ohio	1,800 yards sand, at 7 cents	126.00
	do	2 snags, at $3	6.00
	do	4 logs, at $1	4.00
	Lowell, Ohio	7,020 yards gravel, sand, and mud, at 6 cents.	421.20
	do	4 logs, at $1	4.00
	do	1 steamboat hull	15.16
	do	3 piles, at $1.25	3.75
	Beverly, Ohio	1 tree	11.50
		Total	9,682.53

COMMERCIAL STATISTICS.

Commerce of Muskingum River during the calendar year ending December 31, 1886.

LOCK NO. 1.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	4	2	.....	6	6
February	27	5	14	46	46
March	74	17	43	134	134
April	71	18	27	116	116
May	51	20	61	132	132
June	72	35	22	129	129
July	69	34	30	133	133
August	44	14	8	66	66
September	12	24	7	43	43
October	71	30	10	111	111
November	83	37	3	123	123
December	61	28	12	101	101
Total	639	284	237	1,140	1,140

LOCK NO. 2.

February	28	8	.....	36	36
March	70	12	4	86	86
April	65	7	4	76	76
May	30	7	.....	37	37
June	57	13	4	74	74
July	59	12	4	75	74
August	44	4	3	51	51
September	6	4	1	11	10
October	64	19	2	85	85
November	78	21	3	102	102
December	61	8	.....	69	69
Total	562	115	25	702	700

LOCK NO. 3.

February	30	8	1	39	32
March	70	7	3	80	73
April	67	1	3	71	71
May	27	8	4	39	36
June	54	5	2	61	61
July	59	8	5	72	67
August	41	8	14	63	56
September	18	9	4	31	28
October	71	22	7	100	91
November	88	28	.....	116	102
December	54	7	.....	61	60
Total	579	111	43	733	661

LOCK NO. 4.

February	13	6	1	20	14
March	36	10	9	55	45
April	27	6	3	36	30
May	16	4	10	30	27
June	24	5	5	34	32
July	18	9	6	33	29
August	12	10	10	32	26
September	20	6	4	30	25
October	63	13	5	81	74
November	61	38	7	106	80
December	10	8	.....	18	16
Total	300	115	60	475	406

merce of Muskingum River during calendar year ending December 31, 1893—Cont'd.

LOCK NO. 5.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
uary	5	3	.....	8	5
h	17	6	2	25	19
	18	1	3	22	19
	15	2	4	21	18
	24	14	4	42	28
	14	8	10	32	27
ist	8	5	16	29	22
mber	21	7	4	32	24
er	54	9	3	66	60
mber	52	35	7	94	82
nber	4	2	3	9	9
Total	232	92	56	380	313

LOCK NO. 6.

uary	5	3	2	10	7
h	16	6	2	24	19
	18	3	1	22	18
	9	9	1	19	17
	7	8	1	16	14
	30	54	12	96	70
ist	9	12	10	31	20
mber	19	22	7	48	41
er	45	15	10	70	59
mber	67	22	68	157	146
nber	4	3	2	9	8
Total	229	157	116	502	419

LOCK NO. 7.

uary	4	2	13	19	17
h	19	8	7	34	26
	19	3	5	27	24
	22	10	3	35	28
	4	2	5	11	11
	11	3	11	25	25
ist	16	7	5	28	24
mber	34	13	5	52	44
er	47	7	5	59	51
mber	39	10	2	51	45
nber	8	4	.....	12	11
Total	223	69	61	353	306

LOCK NO. 8.

uary	3	1	.....	4	4
h	74	7	3	84	77
	70	4	.....	74	70
	60	4	5	69	66
	54	4	14	72	72
	68	3	8	79	78
st	83	2	56	141	140
mber	80	7	9	96	96
er	105	4	18	127	125
nber	99	5	10	114	112
ber	67	16	6	89	74
Total	763	57	129	949	914

Commerce of Muskingum River during calendar year ending December 31, 1893—Cont'd.

LOCK NO. 9.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
February	3	.....	.....	3	3
March	71	3	2	76	73
April	73	4	6	83	78
May	60	5	25	90	85
June	53	4	78	135	131
July	62	6	14	82	76
August	97	36	12	145	109
September	81	15	12	108	95
October	98	8	22	128	108
November	102	4	12	118	103
December	54	1	10	65	63
Total	754	86	193	1,033	920

LOCK NO. 10.

February	5	.....	.....	5	4
March	68	3	5	76	72
April	132	68	1	201	135
May	54	.....	.....	54	54
June	55	2	.....	57	57
July	58	3	5	66	57
August	61	1	1	63	60
September	62	.....	.....	62	62
October	90	3	2	95	94
November	91	6	.....	97	95
December	47	5	.....	52	50
Total	723	91	14	828	740

SUMMARY.

Lock No.—					
1	639	264	237	1,140	1,140
2	562	115	25	702	703
3	579	111	43	733	681
4	300	115	60	475	466
5	232	92	58	380	313
6	229	157	116	502	419
7	223	69	61	353	306
8	763	57	129	949	914
9	754	86	193	1,033	920
10	723	91	14	828	740
Total	5,004	1,157	934	7,095	6,539

List showing amount of principal items of freight and the number of passengers carried on the Muskingum River for the calendar year ending December 31, 1893.

Articles.	Amount.	Articles.	Amount.
Passengers ..... number..	49,160	Wool ..... tons..	150
General merchandise ..... tons..	9,670	Lumber ..... do..	42,600
Coal ..... do...	9,554	Brick ..... do...	1,377
Live stock ..... do...	2,650	Hay ..... do...	905
Oil ..... do...	5,250	Salt ..... do...	1,655
Wheat ..... do...	2,100	Potatoes ..... do...	1,610
Corn ..... do...	2,925		

st of steamboats (stern-wheel) plying on the Muskingum River between Zanesville and Marietta, Ohio.

Name.	Length.	Breadth.	Depth.	Draft.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Inches.*	
ghland Mary	160	34	7	24	400
zzie Cassel	138	31½	4½	22	176
M. Bayne	120	24	3½	20	115
ncma	125	20	3½	23	116
.D. Munson	121	22 7/12	4 7/12	16	150
ater Maiden	69	12	2½	24	24
nma	76	14	2½	26	25
ary H	113	18	3 7/12	22	62
el Norte	35½	8 7/12	4½	40	5.34

D D 8.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

During the latter part of November, 1893, there was lying in the pool above Davis Island Dam, Ohio River, some 25,000,000 bushels of coal loaded on barges and boats, all awaiting a rise of sufficient volume to permit towing down the river. A barely sufficient rise occurring on the 29th and 30th, the dam at Davis Island was lowered early on the 0th, and subsequently on that date 82 steamers with 600 coal vessels passed the dam. As was to be expected in this congested state of affairs, combined with the narrow channel available, due to the barely sufficient rise, collisions and accidents of various kinds occurred, causing wrecks of several entire tows and portions of others. Many of these wrecks remained in positions dangerous to navigation. Upon application to the Department, authority of the Secretary of War, dated December 13, 1893, was obtained for the immediate removal of these wrecks, of which the written abandonment by their owners had been made to this office, and authority also given at the same time to remove other wrecks after an authorized advertisement of thirty days. An allotment of $1,500 was made for the work.

Under the authority granted, 11 wrecked coal boats and barges were removed, as shown in the following table:

Location.	Miles from Pittsburg.	Vessel.	Date of removal.
Foot Brunots Island	2¾	1 coal barge	Dec. 15, 1893.
		....do	Jan. 11, 1894.
		1 coal boat	Jan. 11, 12, 1894.
Logstown Bar	16	....do	Jan. 9, 1894.
Jacocks Bar	24½	1 coal barge	Jan. 8, 9, 10, 1894.
Opposite Rochester, Pa	25	....do	Dec. 15, 16, 1893, and Jan. 10, 1894.
		....do	Jan. 10, 1894.
The Clusters	53	....do	Dec. 15, 18, 1893.
		....do	Jan. 6, 1894.
		1 coal flat	Jan. 6, 1894.
Steubenville bridge	66¾	1 coal boat	Jan. 6 and 7, 1894.

The removal of these wrecks practically exhausted the allotment.

On February 9, 1894, a telegram was received by this office from the Secretary of the Pittsburg Coal Exchange, stating that 3 coal boats wrecked near Logstown on the 6th were much in the way of navigation, and requesting immediate removal of them. The facts were telegraphed the Chief of Engineers, with estimate of cost, and recommendation that an allotment of the amount of the estimate, $600, be made,

and that this office be authorized to remove the wrecks, hiring the necessary plant and purchasing the necessary supplies in open market, written abandonment of wrecks by their owners to be obtained before removal. By authority of the Secretary of War, dated February 13, the above recommendation was approved and removal authorized.

Under the authority granted four wrecked coal boats were removed, as shown in the following table:

Location.	Miles from Pittsburg.	Vessel.	Date of removal.
Foot of Logstown Bar	18.2	1 coal boat	Feb. 20-22, 1894.
Below Logstown Bar	18.3	1 piece coal boat	Feb. 22, 1894.
Do	18.6	1 coal boat	Feb. 22-23, 1894.
Head of Crow Island	19.5	....do	Feb. 21-23, 1894.

The work was under the immediate supervision of Mr. E. J. Carpenter, assistant engineer.

D D 9.

PRELIMINARY EXAMINATION AND SURVEY OF MOUTH OF CRAWFISH CREEK, IN FIRST WARD, AND MOUTH OF MILL CREEK, IN TWENTY-FIRST WARD, OF CINCINNATI, OHIO, AS TO AVAILABILITY OF EITHER OR BOTH OF THOSE LOCATIONS FOR AN ICE HARBOR.

[Printed in House Ex. Doc. No. 24, Fifty-third Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 4, 1893.

SIR: I have the honor to submit the accompanying copy of report dated December 2, 1893, of Lieut. Col. Amos Stickney, Corps of Engineers, upon preliminary examination and survey "at the mouth of the Crawfish Creek, in the First ward, and the mouth of Mill Creek, in the Twenty-first ward, of the city of Cincinnati, Ohio, as to availability of either or both said locations for an ice harbor," made under the provisions of sundry civil act of March 3, 1893.

Both of these localities have been heretofore reported upon as to their availability for ice harbors, and a survey of Crawfish Creek has once been made; and it is believed that sufficient information is available to indicate to Congress the advisability of these improvements being undertaken by the United States, and the probable cost of the work. The views of Col. Stickney are adverse to the proposed improvements, and in these views I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, December 2, 1893.

GENERAL: I have the honor to submit the following report upon a preliminary examination and estimate of cost for survey at the mouth of the Crawfish Creek in the First ward, and the mouth of Mill Creek

in the Twenty-first ward, of the city of Cincinnati, Ohio, as to availability of either or both said locations for an ice harbor.

In department letter of March 10, 1893, I was desired to state what, in my opinion, is the least amount that will enable me to make the examination and survey of the localities as required. The preliminary examination has been made without cost by First Lieut. Wm. C. Langfitt, Corps of Engineers, U. S. Army, a copy of whose report is transmitted herewith. The cost of survey is estimated at $600 for the mouth of Crawfish Creek and $1,800 for the mouth of Mill Creek. Both of these localities as to their availability for ice harbors have been reported upon by the late Lieut. Col. Wm. E. Merrill, and by a board of engineers, whose reports will be found in: House Ex. Docs. No. 34, Forty-fourth Congress, second session; No. 41, Forty-fifth Congress, second session, and No. 50, Forty-fifth Congress, third session.

In the case of Crawfish Creek a survey was made under the direction of Col. Merrill, and map forwarded with his report.

A second survey of this locality would be largely a repetition of work already done. A tracing of the map of this survey will be forwarded in a day or two, which, with a revision of the estimate made by Col. Merrill, would, it is suggested, be sufficient, as far as that locality is concerned, to comply with the requirement of the act of Congress, approved March 3, 1893, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1894, and for other purposes."

From investigations heretofore made, it would appear that the construction of ice harbors at the localities named would be exceedingly costly, and that few of the vessels requiring protection would be placed in them.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF LIEUT. WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, November 9, 1893.

SIR: In accordance with your verbal instructions I have made a preliminary examination "of the mouth of Crawfish Creek in the First ward and the mouth of Mill Creek in the Twenty-first ward of the city of Cincinnati, Ohio, as to availability of either or both said locations for an ice harbor," and submit, after a personal examination of both localities, the following report:

Such examination is required by act of Congress approved March 3, 1893, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1894, and for other purposes."

The question of ice harbors for the use and benefit of the river craft frequenting the harbor of Cincinnati has been studied and reported on at different times, several locations being considered, and among them the two in question. From these various reports much information has been taken. The reports to which I would especially refer for fuller details than are given below are the following:

Report of the late Lieut. Col. (then Major) W. E. Merrill, Corps of Engineers, to the Chief of Engineers, dated January 23, 1877, and printed in House Ex. Doc. No. 34, Forty-fourth Congress, second session.

Report of the late Lieut. Col. (then Major) W. E. Merrill, Corps of Engineers, to the Chief of Engineers, dated December 28, 1877, and printed in House Ex. Doc. No. 41, Forty-fifth Congress, second session.

Report of a board of engineers to the Chief of Engineers, dated January 4, 1879, and printed in House Ex. Doc. No. 50, Forty-fifth Congress, third session.

Of the several methods proposed for use on the Ohio River for giving protection from ice floods, such as the building of ice piers or breakers, ice booms, the use of a harbor boat, and the excavation of a lateral basin in the banks, with connection to the river, in which the craft to be protected can be laid up during the period of danger, it is assumed, from the wording of the provision of the act of Congress, that the last method mentioned was the one had in view by its framers, and that method only will be considered here.

The two streams, Crawfish Creek and Mill Creek, near their mouths, may be said to have the following general features in common: Both streams are small and of insignificant discharge in low-water season. Each possesses near its mouth a natural depression or basin of varying extent, separated from the river by high banks, through which the streams empty into the Ohio River by means of a narrow gorge or gully. While the general level of the bottom of the depression is some 20 feet below the level of the surrounding country, and to which it is connected by quite steep slopes, yet it is still some 30 feet above the level of low water in the river. These figures refer more especially to Crawfish Creek, but Mill Creek is very similar, though the actual figures might be somewhat different. They show at once the very large amount of excavation which would be necessary at either place to construct a low-level basin accessible at low-water stages without locks. I will now consider each location separately.

Mill Creek.—Near the mouth of this creek are five bridges crossing it, all at such a level that all would have to be provided with draw spans to permit passage of boats at all required stages of water. Even if changed, they are so close together that there would not be room to operate the draw spans turning horizontally; in fact three of them are practically in juxtaposition. One of these bridges is a massive stone arch, whose clear span would not give sufficient opening for a channel of access to any basin inside. Four of the five bridges are railway bridges and the fifth is a plate-girder highway bridge. The difficulty of coming to an arrangement for the passage of boats through these bridges, which would be satisfactory and just, both to the present owners and users and to the navigation interests, is apparent, and the cost of the necessary changes would evidently be enormous. No other route for an entrance could be selected that would not have to be crossed by these same roads.

Again, what is called the Eighth street viaduct crosses the basin, cutting it in two and reducing the available area, unless a draw were put in and the basin excavated on both sides of the causeway. This viaduct consists of an earthen embankment carrying a roadway, and in addition an elevated structure on iron trestlework, similar to the elevated railways in our large cities. At the crossing of the creek there is a plate-girder bridge resting on massive abutments. Farther up there is still another bridge, which would probably have to be altered to enable full advantage to be taken of the natural depression.

The water of any large basin constructed here would certainly become stagnant during certain portions of the year, and prove inimical to the health of the city near it, unless a large volume of fresh water could be continually diverted into it.

Milk Creek does not carry sufficient water for the latter purpose, and does carry a large amount of sewage and refuse which would aid in rendering the water impure and would also cause deposits which would require dredging. To prevent this, intercepting sewers of large size and great length on both sides of the stream would be necessary and the expense, which would be very great, would have to be borne by the Government. Moreover, if an open connection with the river were made annual dredging would still be necessary on account of the deposits from the river waters. To construct a high-level basin having connection with the river by means of locks would have all the objections already noted, except, perhaps, the last, with the additional one of the much greater expense of the construction, operating, and maintenance of the locks over the open entrance. This greater cost of entrance by locks would be more or less offset, however, by the greater amount of excavation that would be needed in the basin for an open entrance. In any event, in order to keep the basin fresh, a large introduction of fresh water would be necessary. In a report to the Chief of Engineers, U. S. Army, made by the late Lieut. Col. (then Major) W. E. Merrill, Corps of Engineers, dated January 23, 1877, and noted above, this question is discussed, and it is there shown that such introduction could not be made without an expense out of all proportion to the interest involved, and, in my opinion, that conclusion is still good.

Supposing, however, that the harbor under consideration were once constructed, it is at least doubtful if it would be used to any great extent by the river craft. It is a well-known fact that the steamers persist in running up to the last moment, taking their chances of getting into a safe place should the river close with ice. The only use that would probably be made of the harbor would be by steamers which happened to be out of commission at the time of closing of the river by ice, and for the storage of coal barges. And for these barges it would probably only be

used by those companies whose landings were near to the entrance. Finally, the river is only frozen up at this locality on an average once in two years, and in a majority of cases the ice goes out without causing much, if any, damage.

In view of all the above facts, I regard the construction of an ice harbor at this location and of this character as impracticable within any limits of cost commensurate with the amount of benefit that would be derived from it by navigation interests; nor do I regard a survey, only upon the results of which can an accurate estimate be made of the cost of such a harbor, necessary. The cost of such a survey would, however, be about $1,800.

Crawfish Creek.—The construction of an ice harbor near the mouth of this creek was considered by the late Lieut. Col. (then Major) W. E. Merrill, Corps of Engineers, in a report to the Chief of Engineers, dated December 28, 1877, on the best means of protecting the commerce of Cincinnati from ice floods. It was there shown that, without going beyond the boundaries of the natural depression, which would have increased the cost out of all proportion, a harbor having a low-water area of 13 acres, connected with the Ohio River by a dredged channel 60 feet wide could be constructed. * * * The average depth of cutting was found to be 40.9 feet to carry the bottom of the harbor to a depth that boats could enter at all stages of water in the river. From my inspection of the locality and comparison with the map made at the time of the report I should say that the conditions of the site have not materially changed.

Should it be considered necessary or judicious to construct an ice harbor by excavating inside the line of the banks of the river, then this location is one of the most available and convenient for the upper part of the harbor of Cincinnati that could be selected. Its entrance would lead from deep water along a concave shore and there would be as little tendency to silt up, both in the harbor and entrance, as could be found anywhere. But still it is probable that considerable deposit would take place, requiring dredging to maintain the depth. Crawfish Creek itself being so insignificant, its contribution of sediment would probably be small. The flow would not suffice to prevent the water in the harbor from becoming stagnant, and thus the harbor would become a constant menace to the health of the city near it, and, on sanitary grounds, be very objectionable.

But supposing, as in the case of Mill Creek, that the harbor were constructed, the remarks there given as to the probable use that would be made of a harbor apply equally well here, and in addition it may be remarked as to both places that the harbors would probably freeze up before the flowing river closed, and boats seeking them at the critical moment would find them blocked and useless unless the ice in them were kept broken up as fast as formed—a proceeding hardly practicable. Conversely it might easily happen that after closing with ice the river might become clear while the harbors were still frozen up, and craft in them unable to get out when wanted. This would be more liable to happen if a harbor with locks were constructed.

As already stated the largest area obtainable at this location is 13 acres. This area would shelter a maximum of 180 coal barges. There are often during winter in the harbor of Cincinnati several times this many coal barges, not to mention steamers, flats, and other craft. The very limited accommodation that this harbor would afford is evident.

I am, therefore, of the opinion that such a harbor at this location would not prove of sufficient value to navigation interests to warrant its construction, nor do I consider further survey as necessary. Such a survey as would be necessary for accurate estimates of cost of a harbor here would cost about $600.

The construction of a harbor of the character considered in the river itself, at the mouth of either creek or elsewhere, is impracticable because the high-water section of the river is already too small for its volume of discharge without overflow, and at low water it would probably unduly contract the low-water section. In addition it would be speedily filled by deposits of sedimentary matter.

I will conclude this report by a quotation from the Report of the Board of Engineers already referred to. The board says:

"They [the board] are also of the opinion that the natural conditions in the vicinity of Cincinnati are such as to preclude the possibility at any time of constructing satisfactory lateral harbors by excavation in the banks."

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieut., Corps of Engineers.

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.

D D 10.

ESTABLISHMENT OF HARBOR LINES ON BOTH SIDES OF THE OHIO RIVER FROM THE UPPER END OF MARTINS FERRY TO THE LOWER END OF THE CITY OF BELLAIRE, OHIO.

WHEELING, W. VA., *April 30, 1891.*

Your petitioners would respectfully show that on March 5, 1891, the chamber of commerce of the city of Wheeling, W. Va., passed a resolution appointing a committee to take necessary steps to have the harbor lines of the Ohio River established; and that committee having reported in favor of petitioning your excellency and having said petition signed not only by the chamber of commerce but as well as by others in interest on both sides of the Ohio River in the cities and towns of Wheeling and Benwood, W. Va., Martins Ferry, Bridgeport, West Wheeling, and Bellaire, Ohio, and by persons, firms, and corporations interested having property lying between such cities and towns, which report was adopted; therefore, we, the undersigned bodies politic, firms, corporations, and persons having lands fronting upon the Ohio River in the locality above mentioned, or being interested in industries located upon said river front, would respectfully show that Bellaire, West Wheeling, Bridgeport, and Martins Ferry, on the Ohio side of the Ohio River, and Benwood, and Wheeling on the West Virginia side of said river, form almost two continuous cities situated opposite each other and extending along the Ohio River for about 5 miles, containing a population of nearly 70,000, with the people thereof largely and principally engaged in the manufacture of iron, steel, and glass. Your petitioners show that a large number of such manufactories are situated upon the river front and when in operation produce large quantities of waste material, which, to save expense, to raise the banks of the river above average high-water mark (the depth of the river varying from time to time from 1 to 50 feet), and to fill in the low lands along said river, are dumped either over or upon said river bank between high and low water mark. Your petitioners further say and show that for years past in the running of such industrial establishments, the offal or waste from the same has been used in filling up such low lands and in raising the banks of the river above high-water mark; the titles to the lands for the most part of those owning lands on the river front running usually, if not always, to low-water mark. Your petitioners say that in the past few months civil and criminal proceedings have been instituted against citizens and corporations on both sides of said Ohio River, in the towns and cities aforesaid, by the U. S. Government in the Federal courts, and many citizens of West Virginia and Ohio now have either indictments or civil suits pending against them for such dumping. Your petitioners say they wish to obey the law, and that while they desire to dump the waste from their respective places of manufacture upon their own grounds, for the purpose of economy and for the purpose of placing their lands above average high-water mark, which would be a positive advantage to navigation by keeping the Ohio River at such points in fixed limits and thus securing a better and more uniform depth of water, such is the present condition of affairs by reason of the said suits and indictments and the character of land lying along said river, some being at a great distance above low-water mark and others very little, if any, above, with the lands or banks in places jutting out into the river, and at others apparently receding from it and forming low bottom land, subject

to overflow at a very low stage of water, that, in the absence of fixed and positive harbor lines your petitioners can not positively now, and will not in the future with any more certainty be able to, tell where they can or can not lawfully dump their waste material.

Your petitioners in conclusion would respectfully ask your excellency to at once take the necessary steps to have harbor lines fixed and established in accordance with the law authorizing and permitting your excellency to do so, in the cities of Wheeling and Benwood in West Virginia, and in the cities and towns of Ohio on the Ohio River opposite to said cities of Wheeling and Benwood, and also between those cities and towns wherever the corporate limits of the same do not join.

HULLIHEN QUARRIER,
President Chamber of Commerce.
HOWARD HAZLETT,
Secretary Chamber of Commerce.
THE RIVERSIDE IRON WORKS,
F. J. HEARNE, *General Manager.*
BENWOOD IRON WORKS,
ALONZO LONNG, *Secretary.*
WHEELING IRON AND NAIL CO.,
C. R. HUBBARD, *President.*
BELMONT NAIL CO.,
J. D. DUBOIS, *Secretary.*
THE NAIL CITY LANTERN CO.,
A. W. PAULL, *President.*
G. W. SEABRIGHT,
Mayor of the city of Wheeling, W. Va.
J. G. HOFFMANN & SONS CO.,
J. G. HOFFMANN, *Secretary.*

Hon. REDFIELD PROCTOR,
Secretary of War.

[First indorsement.]

MORGANTOWN, W. VA., *May 13, 1891.*

Respectfully referred to the honorable Secretary of War through Lieut. Col. W. E. Merrill, Corps of Engineers, with recommendation that harbor lines be established as speedily as may be, as requested in within petition, in order to avoid litigation and indictments, and at the same time protect the navigable waters in the vicinity of Wheeling and Benwood from encroachments by the municipal authorities, riparian landowners, and others.

GEO. C. STURGISS,
U. S. Attorney, District West Virginia.

[Second indorsement.]

U. S. ENGINEER OFFICE,
Cincinnati, May 15, 1891.

Respectfully forwarded to the Chief of Engineers with the recommendation that harbor lines be established at and near Wheeling as soon as practicable. I would also advise that lines be established on both sides of the river from the upper end of Martins Ferry to the lower end of the city of Bellaire.

WM. E. MERRILL.
Lieut. Col. of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 19, 1891.

Respectfully submitted to the Secretary of War.

This is an application for the establishment of harbor lines on both sides of the Ohio River at Wheeling and Benwood, W. Va., and Martins Ferry, Bridgeport, West Wheeling, and Bellaire, Ohio.

It is recommended that a Board of Officers of the Corps of Engineers, to consist of Lieut. Col. Wm. E. Merrill, Maj. D. W. Lockwood, and Lieut. C. E. Gillette, be constituted to consider and report upon the subject of harbor lines on both sides of the river from the upper end of Martins Ferry to the lower end of the city of Bellaire, as suggested by Lieut. Col. Merrill in the second indorsement; the Board to meet at Wheeling, W. Va., on the call of the senior member. * * *

With the sanction of the Secretary the order constituting the Board will be issued from this office.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fourth indorsement.]

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT, *May 20, 1891.*

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 22, 1891.

Respectfully referred to Lieut. Col. William E. Merrill, Corps of Engineers, for consideration and report by the Board of Engineers constituted by paragraph 1 of Special Orders, No. 32, Headquarters Corps of Engineers, May 22, 1891.

The Board will submit with its report a map showing the harbor lines recommended for adoption.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Sixth indorsement.]

U. S. ENGINEER OFFICE,
Cincinnati, Ohio, June 16, 1894.

Respectfully returned to the Chief of Engineers, U. S. Army, with report of the Board, dated June 15, 1894.

AMOS STICKNEY,
Lieut. Col. of Engineers.

REPORT OF BOARD OF ENGINEERS.

CINCINNATI, OHIO, *June 15, 1894.*

GENERAL: The Board of Engineer Officers, convened to consider and report upon the subject of harbor lines on both sides of the Ohio River, from the upper end of Martins Ferry to the lower end of the city of Bellaire, Ohio, has the honor to submit the following report:

The Board was originally convened by Special Orders, No. 32, dated Headquarters Corps of Engineers, U. S. Army, Washington, D. C., May 22, 1891, and consisted of Lieut. Col. William E. Merrill, Maj. Daniel W. Lockwood, and First Lieut. Cassius E. Gillette, Corps of Engineers.

The first meeting of the Board, which was public, and had been previously advertised, was held at Wheeling, W. Va., June 10, 1891. At this meeting the general subject of the proposed harbor lines was discussed, and it was decided that, in advance of any definite action by the board, a careful survey of the river from the upper end of Martins Ferry to the lower end of the city of Bellaire, Ohio, was required. The following preliminary report was submitted:

CINCINNATI, OHIO, *June 12, 1891.*

GENERAL: The Board of Officers of the Corps of Engineers convened by Special Orders, No. 32, Headquarters Corps of Engineers, Washington, D. C., May 22, 1891, to consider and report upon the subject of harbor lines on both sides of the Ohio River, from the upper end of Martins Ferry to the lower end of the city of Bellaire, Ohio, would respectfully submit the following preliminary report:

The Board met at Wheeling, W. Va., on the 10th instant, pursuant to a call from the senior member, and there had a conference with the representatives of the various industries interested in having harbor lines defined within the limits named in the order. The Board also examined the river front of the city.

As a result of this conference and examination, the Board has the honor to report that in its judgment it is highly important that the harbor lines indicated in the order convening the Board should be defined at the earliest possible date. As there is no reliable map of this stretch of river that is sufficiently in detail to enable the Board to define with accuracy the lines which should be established, it is recommended that a careful hydrographic survey of the Ohio River, within the limits named above, be made under the direction of the engineer officer in charge of the Ohio River, which map when completed shall be submitted to the Board for final action.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.
D. W. LOCKWOOD,
Major of Engineers.
CASSIUS E. GILLETTE,
First Lieut. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Authority having been given therefor, a detailed survey of the banks on both sides of the river, between the limits named in the original order convening the Board, was made under the direction of Lieut. Col. William E. Merrill, Corps of Engineers, and the results have been platted on 10 sheets on a scale of 120 feet to 1 inch.

After the death of Lieut. Col. Merrill, Maj. (now Lieut. Col.) Amos Stickney, Corps of Engineers, was directed by letter from office of Chief of Engineers, dated February 3, 1892, to assume membership of the Board, and by Special Orders, No. 50, dated Headquarters Corps of Engineers, U. S. Army, October 15, 1892, Lieut. Harry F. Hodges, Corps of Engineers, was assigned to duty on the Board in place of Lieut. Gillette, relieved by letter from office Chief of Engineers, U. S. Army, dated June 28, 1892.

The Board was directed to reassemble, upon the call of the senior member, by paragraph 1, Special Orders, No. 12, dated Headquarters Corps of Engineers, U. S. Army, Washington, D. C., March 25, 1893.

Upon the call of the senior member the Board again met at Wheeling, W. Va., April 24, 1893, after due advertisement in the Wheeling and Pittsburg papers. Lieut. (now Capt.) Harry F. Hodges, Corps of Engineers, was unable to be present on account of instructions from the office of *the Chief of* Engineers, U. S. Army, directing him to pro-

ceed at once to Sioux City, Iowa, to assume charge of works in that vicinity. By paragraph 2, Special Orders, No. 18, dated Headquarters Corps of Engineers, U. S. Army, Washington, D. C., April 24, 1893, Lieut. Hodges was relieved as a member of the Board and Lieut. H. E. Waterman, Corps of Engineers, detailed as a member thereof. On April 24 and 25 public meetings were held, in order that all parties interested in the establishment of harbor lines might have an opportunity of expressing their views. Maps were exhibited showing the reach of river within the limits of the proposed lines. These public meetings were not as well attended as had been hoped, but a number of parties, representing the navigation interests, various manufacturing establishments upon the banks of the river, railroads, and the city of Wheeling, were present, some of whom presented their views upon the subject. After giving an opportunity to all who wished to discuss the subject, the Board, accompanied by representatives of the various interests, on the afternoon of April 25, 1893, proceeded to make a personal inspection of the river from Martins Ferry to Bellaire. For this purpose Capt. John K. Booth kindly offered his steamer *Liberty* on behalf of the river interests. Some time after the adjournment of the meeting Mr. F. J. Hearne, general manager of the Riverside Iron Works, presented a communication, accompanied by maps, relating to the proposed harbor lines in the vicinity of Benwood.

DESCRIPTION OF THE LOCALITY.

From the upper end of Martins Ferry down to near the head of Wheeling Island the Ohio River has a width, between natural banks, varying from 1,325 feet to 1,450 feet. In this reach the river is crossed by one bridge, formerly belonging to the Wheeling and Harrisburg Railway, but now a part of the Wheeling Bridge and Terminal Railway system. There are some encroachments made by filling out the banks in this part of the river, but nothing of a serious nature. Wheeling Island divides the river into two branches, the main and navigable branch passing on the West Virginia side. Along this branch the width, between natural banks, varies from about 1,450 to 950 feet. This part of the river is crossed by two bridges, one (the upper) being the old suspension bridge, and the other, a short distance below it, belonging to the Wheeling Bridge Company; just below this bridge is the public steamboat landing of the city of Wheeling, and near the lower end of this landing is a freight house of the Pennsylvania Railroad Company, which, it is said, is built entirely, or almost entirely, upon ground made outside of the natural river bank; outside of the freight house is a platform and a track. The present width of the river at this point is 875 feet. Below the freight house and nearly opposite the lower point of the island is an encroachment made by building out a point into the river by the dumping of slag, etc., over the bank. This is seriously complained of by navigators as throwing the current over toward the opposite shore.

The back channel, in rear of Wheeling Island, has a width between natural banks varying from 750 to 600 feet; it is crossed by two bridges and a dam. It is not navigable except at the head, and on the banks on the main shore are many manufacturing establishments. A railroad track is laid along the bank and there are numerous instances of building out beyond the banks, but nothing of a serious nature.

Below Wheeling Island the river continues with a least width between natural banks of about 1,200 feet until it approaches Boggs

Island, which is small and low. Here the main river is about 1,200 feet wide, with a back channel of 400 feet width. Just below Boggs Island the natural banks were about 1,200 feet apart, the width gradually increasing to about 1,350 feet at the lower end of Bellaire. In this reach the river is crossed by the Bellaire bridge; and in this reach, just below Boggs Island, the most serious encroachments, between Martins Ferry and Bellaire, occur. The Riverside Ironworks on the West Virginia side, and the Bellaire Steel Works on the Ohio side, just opposite each other, have placed slag, etc., beyond the natural banks, so as to contract the river to a width of about 950 feet. These encroachments form a throat through which the entire discharge of the river passes, except in exceptional rises, when the water gets over the banks, and have undoubtedly made considerable changes in the velocity and direction of the current; and it is claimed by the navigators that they have considerably increased the difficulty of passing the Bellaire bridge just below.

CONSIDERATIONS GOVERNING THE BOARD.

Along this stretch of river, from the upper end of Martins Ferry to Bellaire, a distance of about 8 miles by the main channel, there are many and varied interests involved in the establishment of harbor lines, and the board in its recommendations has endeavored to locate the lines in such manner as to best serve, as nearly as possible, the interests of all concerned, though in a few cases, notably that of the Bellaire Steel Works, the action of the parties themselves in encroaching upon the river makes it impossible in securing a proper cross section of discharge for flood waters, and to correct, as far as possible, cross currents, etc., caused by projecting points in this and other cases to avoid placing the lines some distance back from the artificial bank built up by the dumping of slag and mill refuse into the river, a proceeding which has not only afforded the parties interested an economical method of getting rid of the waste material which rapidly accumulates from works of this character, but which also gives promise of additional land, costing practically nothing, for an extension of plant and manufacturing facilities.

Owing to the fact that the river banks and bottom are unstable, and the slopes of the river surface ever changing, the Board has had much difficulty in deciding as to the best method of laying out fixed harbor lines that would be suitable after a lapse of years, and that could be easily and definitely located by interested parties. After a careful consideration of the subject, the following method was adopted: To establish, as nearly as possible, the height of the river surface at a number of points, on both banks, along the reach of river under consideration, when the Wheeling gauge should mark 40 feet. Having the slopes of the lines connecting these points, assume regular slopes which shall nearly coincide with them. Let the lines of intersection of planes passed through these regular slopes with assumed bank slopes of one on three be the harbor lines. Having thus established the lines, let it be provided that filling of the banks, or placing of structures except as hereafter noted, or material of any kind, shall not be permitted beyond planes passing through the harbor lines, and having slopes of one vertical to three horizontal. The lines corresponding to the 40-foot reading on the Wheeling gauge are selected because the surface of the the river, at that stage, is about at the top of the immediate banks.

In laying down the lines, the Board has deemed it proper to follow

as nearly as might be, the present banks of the river, except in cases where an encroaching projection interfered materially with the natural flow of the river.

The black lines, laid down on the maps herewith, are approximately the horizontal projections of the intersection of the proposed authorized slopes of the bank by the surface of the water when the Wheeling River gauge reads 40 feet. If the location of these lines is approved, it is proposed to fix them in horizontal projection by proper references to fixed points, and to fix their elevation by reference to suitable bench marks connected with the Wheeling gauge. The slope of the river banks below the lines marked, except at the public landing of Wheeling, are to be one on three; thus the upper limits of the slopes will be the lines to be known as the harbor lines. At the Wheeling landing the slope of bank is to be one on five, that being about the slope of the existing paved wharf.

It is recommended that no person be allowed to place structures or material of any kind, except bridge piers and necessary structures for public waterworks, on the river side of the slopes above mentioned. Above the 40-foot line it is not deemed necessary to define the slopes of the bank or restrict the owners of abutting property.

After the action of the honorable Secretary of War upon the proposed location of the lines, the Board would respectfully request that the maps be returned, and authority given to have the necessary base lines and level lines run, and suitable monuments and benches placed, when an additional sheet or sheets will be added to the maps, giving precise descriptions by which all points of the lines may be accurately located.

Respectfully submitted.

AMOS STICKNEY,
Lieut. Col. of Engineers.
D. W. LOCKWOOD,
Major of Engineers.
H. E. WATERMAN,
First Lieut. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 18, 1894.

Respectfully submitted to the Secretary of War.

By authority of the Secretary of War of May 20, 1891, a Board of Engineers was constituted to consider and report upon the subject of the establishment of harbor lines on both sides of the Ohio River, from the upper end of Martins Ferry to the lower end of the city of Bellaire, Ohio.

The board has given careful consideration to the questions connected with this matter and submits the within report and accompanying map* (in ten sheets), to which attention is respectfully invited.

The harbor lines selected by the board are shown in light black lines on the map, and the Board recommends that the location of these lines be approved, and that the map be then returned and authority given to have the necessary base lines and levels run, and suitable monu-

* Not printed.

ments and benches placed, after which an additional sheet or sheets will be added to the map, giving precise descriptions by which all points of the lines may be accurately located. I concur in this recommendation and further recommend that the Secretary of War place his approval both upon the report and upon the map.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *June 21, 1894.*

Approved.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX E E.

IMPROVEMENT OF CHEAT, MONONGAHELA, AND ALLEGHENY RIVERS, WEST VIRGINIA AND PENNSYLVANIA.

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monongahela River, West Virginia and Pennsylvania.
2. Operating and care of locks and dams Nos. 8 and 9, Monongahela River.
3. Purchase of Lock and Dam No. 7, Monongahela River.
4. Purchase of Lock and Dam No. 6, Monongahela River.
5. Cheat River, West Virginia.
6. Allegheny River, Pennsylvania.
7. Dam at Herr Island, Allegheny River, near Pittsburg, Pa.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., July 10, 1894.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge during the fiscal year ending June 30, 1894.

I relieved Lieut. Col. Amos Stickney of the charge of these works on December 14, 1893, pursuant to paragraph 10, Special Orders No. 260, Headquarters of the Army, Adjutant-General's Office, Washington, November 10, 1893.

Very respectfully,

R. L. HOXIE,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

E E 1.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

Statement of the amount and date of all appropriations.

June 10, 1872	$25,000
March 3, 1873	66,000
June 23, 1874	25,000
March 3, 1875	22,000
June 18, 1878	25,000

March 3, 1879	$24,000
June 14, 1880	25,000
March 3, 1881	25,000
August 2, 1882	25,000
July 5, 1884	45,000
August 5, 1886	90,900
August 11, 1888	35,000
September 25, 1889 (allotted from appropriation for examinations, surveys, and contingencies of rivers and harbors)	4,000
July 13, 1892	25,000
Total	461,900

The original project for the improvement of the Monongahela River was the construction of two locks and dams to continue slack-water navigation from the head of slack-water navigation of the Monongahela Navigation Company to Morgantown, W. Va., a distance of 14 miles. These locks and dams, known respectively as Nos. 8 and 9, were completed in 1889 and have been in successful operation.

The river and harber act of July 13, 1892, appropriated the sum of $25,000 for the extension of the improvement on Monongahela River by beginning work on an additional lock and dam, which is designated as No. 10, and a survey has been made for the purpose of determining the exact location of this lock, which will be near Morgantown, W. Va.

During the past fiscal year a careful examination has been made of the river in the vicinity of Morgantown, W. Va., for a distance of about 2½ miles measured along the river, for the purpose of fixing definitely upon a site for Lock and Dam No. 10. The interests of navigation appear to require that the site should be fixed at Falling Run, below Morgantown, and this location appears to be an advantageous one for the town. Local opposition having been encountered, the objections raised are now under consideration, with a view to reconciling, if possible, conflicting interests. The appropriation available being sufficient only for the purchase of the necessary land at this site, and preliminary operations to a limited extent, there is plenty of time for reaching a decision in this matter.

Lock and Dam No. 10 will be first in a series of six required for the completion of slack-water navigation to Fairmount. Projects have been presented from time to time for this improvement, but none have been definitely approved as yet. The appropriation of $25,000 in 1892 for the extension of the improvement of the Monongahela River is in line with the recommendations heretofore made, but this improvement will be of little value until completed. The cost of the entire work, including lock-keepers' dwellings and the necessary outbuildings for each lock, will be about $1,320,000, an average of $220,000 for each lock and dam. It will be both economical and advantageous to the United States to make an appropriation of the entire amount required for the completion of the improvement, providing for such annual expenditure as may be thought advisable. The construction of the locks might then be commenced at several points at once, and the construction of the dams could follow, beginning with No. 6, so that no work need be done in pool water with its attendant additional cost and inconvenience.

A new line of steamboats was established on the Monongahela River on March 25, 1894, making daily trips between Brownsville, Pa., and Point Marion, Pa. The State Line Railroad was also completed between Morgantown, W. Va., and Uniontown, Pa., and was opened for business on April 2.

'his work has been under the immediate supervision of Mr. Philip lay, assistant engineer.

[Extract from report of Mr. Philip Golay.]

'ith a view of definitely locating Lock and Dam No. 10, twenty-two prospecting :s were drilled during the past year at various places along the Monongahela er from 2 miles above to one-half mile below Morgantown. Surface indications soundings made through the gravel with a churn drill had led to the conclusion t solid rock foundation could be found in the bed of the river for a considerable ance above Morgantown; but deeper drilling shows that much of the supposed l rock is only a mere shell. Just above the mouth of Coburns Run, 2 miles above gantown, the bed of the river is shale and coal, with sandrock under the coal at pth of about 18 feet below normal pool level. Good rock foundation was found he bed of the river one-half mile above the Morgantown wharf, also near Fall-Run, which is at the lower end of Morgantown.
survey of the necessary land on both sides of the river and of a cross section of river on line of proposed location of dam, has been made, and is represented by ap dated May, 1894.

'he harbor of Pittsburg has suffered from numerous encroachments n the navigable channel of the Ohio, the Monongahela, and the egheny rivers. This matter is now fairly under control, and the stion of new harbor lines has been investigated by a Board ointed pursuant to Special Orders No. 87, Headquarters Chief of gineers, December 20, 1890. The report of the Board has not yet n promulgated, and until the lines which this Board may propose ll have been approved by the Secretary of War, there will be more less difficulty in preventing encroachments.
'he harbor of Pittsburg has been under the immediate supervision Mr. J. W. Arras, assistant engineer.

[Extract from report of Mr. J. W. Arras.]

o difficulty was experienced during the past year in preventing encroachments the navigable channel of the river in the vicinity of Pittsburg. Nearly all of se against whom proceedings had been instituted prior to the end of the fiscal r 1893 continued to observe a strict obedience to the law prohibiting encroach-its on navigable streams, and only a few others offered to make deposits of waste erials in the stream, or otherwise obstruct navigation. Among these the only s requiring mention are Thomas A. Millar, at McKeesport, Pa., and some parties the left bank of the river at the Pittsburg, Cincinnati, Chicago and St. Louis lway bridge, Pittsburg, Pa. The former, in order to reclaim property which he ted had been washed away during freshets, had a double row of heavy piles driven what he claimed was the river line of his tract of land. The piles were driven ng the left side of the Youghiogheny and Monongahela rivers where the former pties into the latter, at McKeesport. The obstruction extends about 400 feet up Youghiogheny River and a like distance down the Monongahela River, and at angle formed by the two streams is fully 150 feet from the bank. Between these s and the bank he proposed to make a permanent embankment. Since the piles proposed embankment encroach on the navigable channel in the Youghiogheny low run, the obstruction would become a very serious one to navigators. Such on has been taken by the U. S. attorney as is expected to secure to the Govern-t the removal of the piles and a permanent injunction.
he encroachment at the Pittsburg, Cincinnati, Chicago and St. Louis Railway ge, Pittsburg, Pa., consists in an embankment of earth, ashes, brickbats, and r waste materials 60 feet wide and 170 feet long, in front of lands of Joseph h & Co.; Robert Adams; Bernard Maloy; Pittsburg, Virginia and Charleston way Company; and Pittsburg, Cincinnati, Chicago and St. Louis Railway Com-. As an obstruction to navigation this is not very serious. Their attention g called to the matter, the parties stopped the filling.
e West Elizabeth bridge was completed and an inspection made. It was found nform to the plans approved by the Secretary of War. Neither this bridge, nor proposed structures, the erection of which is authorized, will interfere with safe ree navigation beyond necessitating such precautions in passing them as bridges neral placed over navigable waters require.
ring the *past year investigations* of encroachments were made in the following

cases: L. M. Morris, at Twenty-sixth street, Pittsburg; Marshall Foundry and Structural Works, at Twenty-eighth street, Pittsburg; Pennsylvania Salt Manufacturing Company, at Natrona, Pa.; Allegheny City, at foot of Anderson street, Allegheny, Pa.; Emil Winter Company, at Herr Island; Pittsburg city dump boat, at Fourth street, Pittsburg. Legal proceedings were instituted against the first-two-named parties by the U. S. attorney. The complaints against the Pennsylvania Salt Manufacturing Company, and Allegheny City, were found to be practically groundless, and, their attention being called to the matter, the Emil Winter Company and the operators of the Pittsburg city dump boat ceased placing waste material into the river.

Money statement.

July 1, 1893, balance unexpended	$23,598.49
June 30, 1894, amount expended during fiscal year	2,134.41
July 1, 1894, balance unexpended	21,464.08
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	200,000.00

COMMERCIAL STATISTICS.

Commerce that passed through United States Lock No. 8 during 1893.

Month.	Ascending.		Descending.		Month.	Ascending.		Descending.	
	Passengers.	Freight.	Passengers.	Freight.		Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*			*Tons.*		*Tons.*
January (river frozen)					August	1,978	521.85	2,152	901.74
February	360	634.62	497	425	September	976	451.08	1,050	336.78
March	471	832.70	555	360.25	October	764	202.25	828	845.50
April	408	715.50	519	2,165.24	November	439	937.35	421	509.55
May	730	317.35	719	2,302.98	December	378	322.60	437	382.50
June	1,673	463.93	1,611	2,753.24					
July	3,928	297.62	3,640	987.48	Total	12,105	5,696.85	12,429	11,890.28

Commerce that passed through United States Lock No. 9 during 1893.

Month.	Ascending.		Descending.		Month.	Ascending.		Descending.	
	Passengers.	Freight.	Passengers.	Freight.		Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*			*Tons.*		*Tons.*
January (river frozen)					August	2,177	1,186.39	1,851	552
February	422	317.50	407	578.75	September	987	1,512	978	56.25
March	496	981	430	285.49	October	780	1,156.25	736	117.25
April	467	1,185	443	2,197.25	November	446	1,794	369	911
May	768	915.25	744	1,881.70	December	393	408.50	361	414.25
June	1,696	784.05	1,567	731.90					
July	4,028	879.80	3,377	581.25	Total	12,660	11,119.74	11,272	8,397.09

These tables show that the commerce during 1893 on the 14 miles of the Monongahela River, which is controlled by the United States, was as follows:

Tons of freight	18,506.97
Passengers	24,233

e following table, compiled from the annual reports of the Monongahela Navi-on Company, shows the commercial movement on the lower part of this river for ast eight years:

Articles.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
.....	8,997	5,279	4,504	6,333	7,856	7,897	8,181	6,344
and horses..	386	501	565	729	648	783	647	611
ified freight..	13,086	16,486	17,450	18,334	23,169	21,746	21,891	20,076
nd coke	4,297,768	2,998,690	4,400,996	3,084,175	4,486,322	4,291,874	3,884,162	3,865,592
lay	3,295	2,383	3,476	5,982	5,021	6,193	4,720	220
.....	83	259	379	266	340	302	107	81
{ Ore.....	17,823	17,683	8,079	3,371	2,335	.....	.....	.....
{ In pigs....	5	7	10	15	5	3	.....	.....
er.	10,231	11,144	13,778	10,095	11,615	25,887	23,738	22,331
.....	.....	55	.....	.....	.....	.....	.....	.....
.....	.....	2,285	.....	.....	2,394	.....	.....	.....
.....	437	258	489	700	1,089	4,910	.....	2,256
, pit.....	18,392	30,472	22,432	18,707	29,336	9,786	14,952	4,194
ad ties	161	30	555	3,165	232	160	.....	.....
.....	59,229	89,230	63,085	73,590	105,600	74,600	89,900	113,400
.....	108	233	193	164	60	112	123	207
s.....	9	.....	7	26	140	109	98	178
rails	45,795	57,490	10,688	32,177	34,609	11,422	29,391	19,866
.....	4,621	910	3,636	9,580	811	4,595	2,120	5,647
er.....	52,698	53,561	84,191	54,696	43,970	67,164	81,759	80,000
ky	164	49	88	134	180	922	1,515	1,641
.....	196	.....	184	.....	58	.....	.....	.....
Total	4,533,484	3,287,005	4,634,785	3,322,239	4,755,790	4,528,465	4,163,304	4,142,644
ngers	26,885	50,584	44,714	45,811	31,828	48,744	80,590	98,440

Bridges completed over Monongahela River and its branches.

Name.	Distance above mouth.	Kind.	Spans.	Channel span.		Name of pool or branch in which located.
				Clear width on low-water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
.....	0.0	Highway.	1	780	73.3	Davis Island Dam.
field street.....	.8	....do	2	344	55	Do.
urg, Cincinnati, Chicago St. Louis Rwy.	1	Railroad..	5	247	53	Do.
street.....	1.3	Highway.	3	195	54	Do.
ngahela Connecting Rwy	2.8	Railway..	6	300	51.8	No. 1, Monongahela River.
nore and Ohio (Glenwood) ...	6	....do	8	184	57	Do.
urg, McKeesport and Youghheny (Homestead).	8	....do	6	250	54	Do.
ylvania R. R. (Port Perry)...	11.8	....do	9	253	57	Do.
esport and Duquesne.....	14.5	Highway.	4	305	57	No. 2, Monongahela River.
esport and Bessemer	14.6	Railroad..	5	325	51.5	Do.
urg, McKeesport and Youghheny (McKeesport).	15.5	....do	6	221	40	Youghiogheny River.
esport Suspension.....	15.5	Highway.	3	305	43	No. 2, Monongahela River.
View	16	....do	3	258	40	Do.
sburg.....	16.2	....do	4	350	51.8	Do.
n.....	18	....do	3	337	45.03	Do.
beth.....	23	....do	3	350	51	Do.
ngahela City	32.5	....do	4	216	42	No. 3. Monongahela River.
and Baltimore Short Line R. Greenfield).	52	Railroad..	4	238	52	No. 4, no superstructure.
ylvania R. R. (Redstone)....	56	....do	4	262	40	No. 4, Monongahela River.
nsville	57.3	Highway.	3	218	41.5	Do.
Line R. R. (Point Marion)...	90.5	Railroad..	5	109	33.5	Cheat River.
antown.....	102	Highway.	1	606	45.7	No. 9, Monongahela River.
nore and Ohio R. R. (near rmount, W. Va.).	125.5	Railroad..	.....	.....	.....	Above slack water.
ount Suspension.....	126.5	Highway.	4	190	39	Do.
imore and Ohio R. R. (near *rmount, W. Va.).*	127	Railroad..	.....	.....	.....	Do.

Bridges authorized and not completed.

Name.	Distance above mouth.	Kind.	Spans.	Channel span.		Name of pool in which located.	Date of issue of charter or approval of act of Congress.
				Clear width on low-water line.	Clear height above normal pool level.		
	Miles.			*Feet.*	*Feet.*		
South Twenty-second street, Pittsburg.	2	Highway.	5	380	53	No. 1....	.....
Six-Mile Ferry, near Pittsburg.	5	... do	4	370	53.75	...do	.....
Homestead.....	7	....do	5	350	52	...do	Feb.14,1893.*
Youghiogheny Central Rwy. Co., near Dawson.	51	Railway ..	3	95	20	No. 2....	.....

Name.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
South Twenty-second street, Pittsburg.	Dec. 26, 1891†	2 years from date of charter ..	5 years thereafter.
Six-Mile Ferry, near Pittsburg.	Aug. 21, 1891†	.....do	Do.
Homestead.....	May 24, 1893†	1 year from date of approval..	3 years from date thereof.
Youghiogheny Central Rwy. Co., near Dawson.	Sept. 24, 1892†	2 years from date of charter ..	5 years thereafter.

* Date of approval of act of Congress. † Company chartered by State of Pennsylvania.

E E 2.

OPERATING AND CARE OF LOCKS AND DAMS NOS. 8 AND 9, MONONGAHELA RIVER.

The Monongahela River from Morgantown, W. Va., to its mouth at Pittsburg, is canalized by nine locks and dams, of which the first seven, counting from Pittsburg, are the property of the Monongahela Navigation Company, and the eighth and ninth are the property of the United States. The eighth dam is 88.15 miles above Pittsburg, and Morgantown, the head of the slack water, is 102.16 miles from the same. It may, therefore, be stated that 14 miles of this river is under the direct control of the United States and 88 miles is under a private corporation.

The following is a statement of date and amount of all allotments for this work:

August 5, 1884.....	$1,000.00	October 27, 1888.....	$3,000.00
September 1, 1884.....	4,000.00	July 17, 1889	1,480.00
November 3, 1884.....	4,500.00	October 7, 1889.....	1,500.00
December 20, 1884.....	500.00	November 8, 1889.....	1,200.00
June 1, 1885.....	100.00	July 24, 1890	12,300.00
July 22, 1885	1,000.00	July 9, 1891	24,250.00
July 15, 1886	1,200.00	July 21, 1892	34,017.86
March 1, 1887.....	1,100.00	July 21, 1893	23,574.72
July 1, 1887	11,000.00		
July 11, 1888	6,270.00	Total	131,992.58

During the last fiscal year these locks have been successfully operated without interruption to navigation except by high water on the night of February 4–5.

From Pools 8 and 9 obstructions have been removed aggregating 335 tons of logs, stumps, trees, etc. Dredging in the two pools amounted to 9,560 cubic yards. A new blacksmith shop was constructed at each

lock to take the place of the old one. At Lock No. 8 repairs were made to some of the outbuildings, new valves were placed at head of the turbine races, and repairs made to the operating machinery, to the coping of the lock walls, and the paving below the abutment. Bank protection below the lock was completed. The dam remains as repaired in 1891. At Lock No. 9 the Stoney valve continues to give trouble, and requires frequent repairs. Orders have been placed for material to reconstruct the lock gates. The concrete dam has been restored to its original height, giving 2 feet additional depth of water in Pool No. 9. Two new dwellings for lock-keepers have been completed.

This work has been under the immediate supervision of Mr. Philip Golay, assistant engineer.

[Extract from report of Mr. Philip Golay.]

These locks have been successfully operated during the fiscal year without interruption to navigation except by high water which overflowed the lock walls at Lock No. 9 to the depth of 8 inches on the night of February 4 and 5, detaining the ascending steamboat from midnight till 8 o'clock next morning.

The launch *Albatross* received some minor repairs and is in good condition. From January 31 to March 20 she was laid up in winter quarters at Lock No. 9. During the fiscal year she ran 2,430 miles, rendering valuable and efficient service as a ready and quick means of visiting the locks and transporting tools and light supplies from Morgantown to the locks and from one lock to the other.

From November 13 to December 5 a force of men with the two decked flats rigged up with derrick and A-frame on them and under tow of the steamboat *Two Brothers*, hired from Hulings Bros., Pittsburg, Pa., were employed removing snags and other obstructions from Pools 8 and 9. During this period of work, 41 snags aggregating 207 tons, 24 trees aggregating 121 tons, 1 hewed log weighing 1 ton, and 1 stump weighing 6 tons were removed and suitably disposed of, leaving the channel clear. The trees had fallen from the banks and lay with their tops extending out into the channel. Cost of this work, $715.

Two new blacksmith shops were constructed in place of the old dilapidated ones, which have since been torn down and cleared away. The new builings are substantial frame structures, 20 feet square, and are located, one at each lock, on the upstream end of the United States land, 20 feet to the rear of the new storage sheds.

LOCK AND DAM NO. 8, MOUTH OF DUNKARD CREEK.

Repairs, etc.—The summer kitchens were underpinned with rubble masonry.

Metal valves were placed at the head of the turbine races in place of the original wooden valves which warped so that they had to be abandoned. The turbine races were also plastered to prevent leaking.

A new worm wheel was procured for operating the gate and valve at the lower end of the land wall. The teeth in the old one had almost worn out. The remaining three worm wheels are much worn and should soon be replaced by new ones. Other minor repairs were made on the operating machinery. Some repairs were also made on the coping of the lock walls and on the paving below abutment on the west side of the river.

Protection of the bank below the lock was begun in the fall of 1892 and was finished during the past fiscal year. On account of the spouty condition of the bank, an underdrain of riprap stone extending from near the lower wing wall of the lock down the river to the boundary line of the United States land, was made about halfway up the slope with lateral drains 50 feet apart leading toward the river. For a distance of 274 feet down the river from lower end of guide crib, and near the edge of the water at normal pool level, a footing was made, i. e., a trench was excavated to the depth of 4 feet and filled with broken stone. Along the entire length of this footing the slope above was graded and riprapped up to contour, about 15 feet above normal pool level. There has been no further caving since the completion of this work and but very little high water to test its efficiency.

Condition of the dam.—The injuries to the dam caused by the floods of 1890 were partially repaired in 1891. On account of the very brief low-water season of that year the raised upper courses of sheeting and purlins beneath could not then be replaced and bolted down. A completion of the repairs has not since seemed imperative; and because of the raised condition of the sheeting and purlins, the comb of the dam remains elevated to such height as to cause Pool No. 8, during low water, to

stand about 1 foot above normal pool level. During the past year the Monongahela River has been comparatively free from freshets and heavy ice, and the dam shows no signs of additional injury; but to insure safety, the repairs should be completed during the approaching low-water season.

Dredging.—From September 16 to 27, the dredging outfit of the Drake & Stratton Company of Pittsburg was employed to do necessary dredging in the forebay and in the channel below the lock. Two thousand two hundred cubic yards of material was dredged and dumped above the dam for additional backing, and 1,600 cubic yards cast up on the beach below the guide crib, and used for grading in connection with protecting the bank below the lock, making a total of 3,850 cubic yards. One log, 7 stumps, and an old cofferdam were also removed from the forebay. Cost of the work, $945.

LOCK AND DAM NO. 9, HOARDS ROCKS.

Repairs, etc.—In May the discharge (Stoney) valve was found to be partially disabled because of the splitting of the channel bars in which the traveling rollers run. New channel bars were ordered at once, but were not received at the lock in time to make the repairs before the close of the fiscal year.

The timber in the lock gates is much decayed, and the gates are considered unsafe. Orders have been placed for material for building new ones, and this work will be commenced soon. A broken gate arm in lower gate, land wall, was repaired in May by a fish splice.

The rough, quarry-face guide wall below the lock was sheathed with timber. This work was under way at the beginning of the fiscal year, was finished in October and meets with universal approval by steamboatmen.

In October also the dam was restored to original height with concrete composed of one part giant Portland cement, two parts sand, and three and one-half parts of stone broken into small pieces the size of 1½-inch cubes and less. The whole was then finished off with cement mortar composed of equal parts of giant Portland cement and sand. The work was commenced on the 7th and finished on the 30th of the month. To insure a firm bond, the surface of the old masonry was picked off with points before the fresh concrete was placed upon it. Recent careful examination shows it to have stood very well, and the 2 feet increase in the depth of water of Pool No. 9 is a great advantage to navigation.

Two new dwellings for lock-keepers, commenced in May, 1893, were finished in December at a cost of $6,500. They take the place of the dwellings carried away by the flood in July, 1888. In the intervening years, the lock-keeper occupied his own house on land immediately adjoining the Government ground; and the assistant lock-keeper used the office for quarters.

Dredging.—From August 31 to September 15 the dredging outfit of the Drake and Stratton Company removed 5,710 cubic yards of material from below the lock, dumped it above the dam, and cast it up for a cofferdam while restoring the dam to original height. Cost, $1,385. After work on the dam was finished, the cofferdam material was leveled down for backing and still remains in place.

Detailed statement of expenses incurred in operating and care of locks and dams on the Monongahela River during the fiscal year ending June 30, 1894.

Month.	Operating expenses.				Repairs.				Tools and appliances.	Grand total.
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Hire of boats and barges.	Labor.	Material.	Total.		
1893.										
July	$670.00	$1.00	$10.00	$681.00	.....	$1,318.12	$524.24	$1,842.36	$2.30	$2,525.66
August	430.00	1.00	44.73	475.73	$3.00	1,145.01	749.99	1,898.00	669.10	3,042.83
September	605.00	1.00	13.50	619.50	2,255.00	2,792.79	1,544.23	6,592.02	16.02	7,227.54
October	560.00	31.04	30.10	621.14	.....	1,992.25	811.09	2,803.34	90.00	3,514.48
November	560.00	.....	12.73	572.73	.....	1,377.37	775.27	2,152.64	.....	2,725.37
December	560.00	1.20	69.94	631.14	485.00	1,435.09	1,252.40	3,172.49	.....	3,803.63
1894.										
January	270.00	4.43	30.70	305.13	.....	4.67	17.43	22.10	.....	327.23
February	520.00	31.56	26.04	577.60	.....	.....	.....	.....	.....	577.60
March	659.17	4.50	19.10	682.77	5.00	.....	.....	5.00	.....	687.77
April	576.00	6.45	28.71	610.16	.....	.....	16.66	16.66	.....	626.82
May	560.00	37.55	12.50	610.05	.....	49.20	38.25	87.45	18.76	716.26
June	726.67	2.10	25.50	754.27	.....	13.50	2,138.36	2,151.86	3.50	2,909.63
Total	6,695.84	121.83	323.55	7,141.22	2,748.00	10,128.00	7,867.92	20,743.92	799.68	28,684.82

Commercial statistics are attached to the report for the improvement of Monongahela River.

E E 3.

PURCHASE OF LOCK AND DAM NO. 7, MONONGAHELA RIVER.

The case of the United States *v.* The Monongahela Navigation Company, for the condemnation of this structure, was heard in the circuit court of the United States for the western district of Pennsylvania in November, 1890, and the value of the work was fixed at $209,000. The navigation company took an appeal to the Supreme Court of the United States, where the case was argued at the October term, 1892. The judgment of the circuit court was reversed and case remanded with instructions to grant a new trial.

[*Decision.*—October term, 1892.—Statement of the case.—Monongahela Navigation Company *v.* United States.—Appeal from and error to the circuit court of the United States for the western district of Pennsylvania.—No. 722.—Argued October 25, 26, 1892.—Decided March 27, 1893.]

In the proceedings taken under the act of August 11, 1888 (25 Stat., pp. 400, 411, c. 860), to condemn Lock and Dam No. 7 of the Monongahela Navigation Company, that company is entitled, under the provisions of the fifth amendment to the Constitution, to recover compensation from the United States for the taking of the franchise to exact tolls, as well as for the value of the tangible property taken.

The assertion by Congress of its purpose to take the property which that company had constructed in the Monongahela River by authority of the State of Pennsylvania did not destroy the franchise granted to the company by the State. * * *

The judgment, therefore, will be reversed, and the case remanded with instructions to grant a new trial.

Money statement.

July 1, 1893, balance unexpended	$161,835.45
June 30, 1894, amount expended during fiscal year	3.68
July 1, 1894, balance unexpended	161,831.77

E E 4.

PURCHASE OF LOCK AND DAM NO. 6, MONONGAHELA RIVER.

Under the act of Congress no steps can be taken toward the condemnation of this lock and dam until the United States has acquired title to Lock and Dam No. 7.

Money statement.

July 1, 1893, balance unexpended	$167,000.00
July 1, 1894, balance unexpended	167,000.00

E E 5.

IMPROVEMENT OF CHEAT RIVER, WEST VIRGINIA.

The river and harbor act of September 19, 1890, contained an appropriation of $13,000 for the improvement of Cheat River. This is the only appropriation ever made for this river.

The object of the improvement was to make the river navig[illegible] loose logs, *so as to bring* out the immense supplies of timber [illegible]

the virgin forests on the Cheat River and its tributaries. In its natural condition it was impossible to bring down rafts, and a large percentage of the loose logs was stranded among the rocks and left there to decay.

The rough part of the river commences about 3 miles below Rowlesburg and terminates at Beaver Hole, 16 miles above the mouth, where the river emerges from Laurel Ridge. The total length of difficult river is 30 miles. The original project for the improvement of the river was the removal of such rock obstructions as interfered with the free passage of logs on a 6 or 8 foot stage of water. At the suggestion of lumbermen and others interested in the improvement of this river, an additional project was adopted of making a low-water channel from near Rowlesburg down the river, in which logs could be floated on a rise of from 2 to 3 feet. The improvement was completed so far as the funds available permitted in 1892, since which time no work has been done. The channel has been greatly improved, and is now in fair condition between Rowlesburg and Green Island, a distance of 20¼ miles.

An additional sum could be advantageously expended in removing more rock from the channel. Between Pringle Run and Green Island 3,000 cubic yards of rock, mostly in the low-water channel, and between Green Island and Forge Island 7,000 cubic yards of rock could be thus removed. Guide cribs should also be constructed at the heads of some low bars to keep logs in the channel.

For the excavation of rock and construction of cribs the sum of $20,000 could be expended to advantage.

This work has been under the immediate supervision of Mr. Philip Golay, assistant engineer.

Money statement.

July 1, 1893, balance unexpended	$7.50
June 30, 1894, amount expended during fiscal year	1.14
July 1, 1894, balance unexpended	6.36
Amount that can be profitably expended in fiscal year ending June 30, 1896. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	20,000.00

Timber product of Cheat River for year ending December 31, 1893.

Month.	Received by mills at mouth of river.	Passed on to points below.	Total.	Month.	Received by mills at mouth of river.	Passed on to points below.	Total.
January (river frozen)	*Tons.*	*Tons.*	*Tons.*	August	*Tons.* 527.78	*Tons.* 15.83	*Tons.* 543.61
February	941.67	28.25	969.92	September	179.84	5.39	185.23
March	44.46	1.33	45.79	October	1.58		1.58
April	76.47	2.29	78.76	November	131.76	4.	135.76
May	3,772.26	113.17	3,885.43	December	28.08	.84	28.92
June	401.87	12.05	413.92				
July	393	11.79	404.79	Total	6,498.77	194.94	6,693.71

Timber product of Cheat River for twenty years ending December 31, 1893.

Year.	Received by mills at mouth of river.	Passed on to points below.	Total.	Year.	Received by mills at mouth of river.	Passed on to points below.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1874	440.83	146.95	587.78	1884	540.83	180.28	721.11
1875	340.83	113.61	454.44	1885	5,540.83	1,846.94	7,387.77
1876	187.17	63.06	250.23	1886	4,527.50	1,509.17	6,036.67
1877	173.83	57.95	231.78	1887	6,035.83	2,011.94	8,047.77
1878	186.67	62.22	248.89	1888	3,612.50	1,204.17	4,816.67
1879	233.33	77.78	311.11	1889	5,625.00	1,875.00	7,500.00
1880	425.00	141.67	566.67	1890	3,741.17	1,247.06	4,988.23
1881	383.33	127.78	511.11	1891	13,310.10	665.51	13,975.61
1882	428.33	142.78	571.11	1892	13,059.55	652.98	13,712.53
1883	916.67	305.56	1,222.23	1893	6,498.77	194.94	6,693.71

The year was remarkable for low water. Had there been a good rise in Cheat River during the latter part of the season the timber output would have greatly exceeded that of any previous year.

E E 6.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The following is a statement of the amount and date of all appropriations for this river:

March 3, 1879	$10,000
June 14, 1880	20,000
March 3, 1881	25,000
August 2, 1882	15,000
July 5, 1884	35,000
August 5, 1886	30,000
August 11, 1888	25,000
September 19, 1890	20,000
July 13, 1892	25,000
Total	205,000

The original condition of the Allegheny River as to depth, width, and navigability can not be stated in definite figures, as there is no defined plane from which to measure, both the low water and the elevation of the river bed being variable. The approved project for the improvement of the river is the removal of obstructions from the channel and the construction of low dams to close double channels, and of dikes to confine the waterway where the river is too wide. Much benefit to navigation has resulted.

During the past fiscal year repairs have been made to the Corydon log chute, the abutments of the Hickory Dam, paving of the dike at Red Bank, and the dam at Nicholsons Island. Operations were commenced on the construction of a dam below Tionesta Creek, partially closing a back channel of the river. This was completed and sustained some damage during the winter, which has been repaired. The construction of a dam and dikes at Cowanshannock Ripple was commenced, the dam completed, and the dikes partially completed. Obstructions were removed from the river channel, aggregating 3,311 cubic yards of rock and fifty snags.

The amount available will be expended during the present working season in the completion of the improvement at Cowanshannock Ripple and continuing the work of removing obstructions from the river channel.

This work has been under the immediate supervision of Mr. J. W. Arras, assistant engineer.

[Extract from report of Mr. J. W. Arras.]

The work under contemplation at the beginning of the year comprised small repairs to a portion of the existing works, which had sustained slight damage from ice gorges during the previous winter, the construction of a low dam at the mouth of Tionesta Creek, and of a dam and two dikes at Cowanshannock Ripple, and the removal of rock and other obstructions from the channel between Tionesta and the mouth of the river.

Repairs to existing works.—These repairs were made during the month of September. Forty feet, linear, of the timber covering of the Corydon log chute, the raising of which was due to a break in the adjoining mill dam, caused by an ice gorge, was taken up and replaced. No new material was required. The cost of the work was $49.24. The slight damage done to one of the abutments of the Hickory Dam by an ice gorge during the previous winter was repaired at a cost of $7.74. Some displaced paving of the dyke at Red Bank was restored, the material scoured out having been recovered. The cost of the labor was $7.36. The damaged paving of the dam at Nicholsons Island, due to the washing out of some decayed timbers, was repaired. The material which had washed out was recovered and replaced at a cost of $29.96.

According to recent reports all of these works are at present in good condition, as are also the dams at Cornplanter, Pithole, and Six-Mile Islands.

New works.—On September 14 operations were commenced on the construction of a low dam across the back channel of the river below the mouth of Tionesta Creek, 152 miles above Pittsburg. This work was completed on October 19. The length of the structure is 298 feet, its width 16 feet, and height above low water 2 feet; its average height above foundation is 3.5 feet. The dam is a timber crib work with rubble stone filling, paved with stone to a depth of 12 inches, and covered on the lower slope with 6-inch oak planking. An abutment about 40 feet long was built at each end to the level of the top of the bank.

The following is a statement of the quantities of material used in the construction of the work:

White oak lumber	feet, B. M.	42,938
Hemlock lumber	do	19,605
Drift bolts	pounds	7,232
Spikes	do	67
Riprap stone	cubic yards	633
Excavation	do	160
Total cost, including labor		$2,204.90

This improvement was designed to assist in getting the shipments of Tionesta Creek out into the main channel of the river after they have reached the channel back of the island opposite the mouth of the creek. Beginning at Tionesta and extending 2 miles down the stream, the Allegheny is divided into two channels by a series of islands. Into the left, or back channel, empties Tionesta Creek, out of which are shipped annually over 20,000,000 feet B. M. of lumber, considerable timber, and 200 coal boat bottoms and from 50 to 100 flats and barges designed for the Monongahela River coal trade. This back channel is of an inferior order, being navigable only when there is upward of a 3½-foot stage of water in the river. Since it is desirable, however, to ship much of the product of the Tionesta, particularly the barges, flats, and coal-boat bottoms, at lower stages of water, it has been necessary, prior to the construction of the dam, to tow these craft up the narrow chute connecting the main channel with the back channel at the mouth of the creek. To accomplish this, timber men and navigators have for many years constructed temporary "buck dams" across the back channel below the mouth of the creek. These dams washed out during the freshets. The dam erected has raised the water 2 feet above the low-water level and affords permanent relief. The object in building this dam to a height of only 2 feet above low water was to permit of navigation over it when the stage of water is upward of 3½ feet, and to avoid the destruction of the water power at the sawmills of Messrs. Lawrence & Smearbaugh, located a short distance above the mouth of Tionesta Creek.

Navigation in the back channel has also been materially improved in the vicinity of the dam by the removal of the remains of several old ice piers and a milldam which seriously obstructed it.

After the winter freshets it was discovered that the abutment at the mainland had been slightly undermined. A small quantity of heavy bowlders was placed along its face and no further trouble is anticipated. The dam is said to be in good co[illegible].

Active operations on the construction of a dam and dikes at Cowanshannock Ripple, 48 miles above Pittsburg, were not commenced until about the middle of October, after which rises of the river were so frequent that little had been accomplished when the setting in of winter compelled an abandonment of work for the season. The dam between the bar and the right bank, which was built entirely of riprap stone, was completed early in November. Its height is the level of a 2-foot stage of water; its width at the top 5 feet, the slopes being 1 foot on 1½ feet; and its length 402 feet. Three hundred and forty and three-tenths cubic yards of stone were used in its construction, at a cost, including labor, of $450. The timber work for Dike No. 1, located on the right shore, directly opposite the mouth of Cowanshannock Creek, was nearly completed. This consisted of 95 oak piles, driven 10 feet into the river bed, 7,253 feet, B. M., of oak timber bolted to the piles at the level of a 1-foot stage of water, and 75 screw bolts. Two hundred and fourteen cubic yards of rubble stone were also put in place. When, on November 22, it became necessary to suspend operations because of high water and ice, the remaining material for Dike No. 1 and that for Dike No. 2, located 2,000 feet farther down the stream, were stored on the bank for safe-keeping during the winter.

These dikes, when completed, together with the dam already built, are intended to concentrate the water and deepen the channel by scouring out the river bed.

Removal of obstructions.—The removal of rock and other obstructions from the channel between Tionesta and Pittsburg was commenced on August 28. Three parties, each composed of 1 overseer, 6 laborers, and 2 teamsters, with teams, were employed on this work. The parties operating between Tionesta and Kennerdell, and between Kennerdell and Cowanshannock, were unable to cover their territories because of frequent interference by rises. The party at work below Cowanshannock completed its work. Three thousand three hundred and eleven cubic yards of rock and 50 snags were taken out of the channal. In the prosecution of this work $1,669.44 was expended.

Occupancy of or injury to public works.—No information has been received that any piers, breakwaters, or structures, or works of any kind on the Allegheny River, belonging to the United States, have been used, occupied, or injured by anyone.

Bridges.—The relief bridge at Oil City, Pa., and the Allegheny Bridge Company's bridge, at Sixth street, Pittsburgh, Pa., were completed during the year and inspections made. They were found to have been built in conformity with the plans approved by the Secretary of War. These bridges offer no interference to free and safe navigation except such as is common to bridges in general built across navigable streams in this vicinity.

No other changes are known to have been made in the bridges over the Allegheny River.

Structures interfering with navigation.—The Corydon Milldam, which for many years has been a source of great trouble, frequently accompanied by loss of property to navigators, and for the safety of navigation over which the Corydon log chute was finally built, was originally constructed across the main channel of the river from the head of Corydon Island to the right bank. During the freshets the water has repeatedly cut its way through, between the dam and the island, but until recently the owners have always repaired the breaks. During the past winter another washout occurred, which, although insignificant at first, was not repaired. The freshet which occurred in May widened the gap, until now the distance between the dam and the island is about 270 feet. Although nothing definite has been received from the owners of the dam as to their intentions, it has been intimated by persons residing in Corydon that they may abandon the structure. In such an event it has been complained of that navigation at that point will be blockaded, and it may become necessary to cause the remains of the dam to be removed.

Money statement.

July _, 1893, balance unexpended	$23,057.46
June 30, 1894, amount expended during fiscal year	8,844.98
July 1, 1894, balance unexpended	14,212.48
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	25,000.00

COMMERCIAL STATISTICS.

Arrangements have been made with the secretary of the Chamber of Commerce of Pittsburg to procure statistics of the commerce of the Allegheny River of which no official record is kept. The information collected by this office for the calendar

year 1892 is submitted herewith, in the absence of information from the Chamber of Commerce:

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Barges	4,860	Lath	575
Bark	3,215	Manure	8,325
Barrels	900	Nitroglycerin	1
Boat bottoms	28,656	Piles	4,113
Brace poles	688	Pit posts	5,437
Cattle and horses	286	Rough lumber	92,602
Check posts	1,205	Sand	64,009
Coal	195	Shingles	400
Fire clay	3,120	Staves	525
Gas pipe	450	Stone	18,570
General freight	1,928	Timber	104,013
Gravel	10,332		
Hay	300	Total	354,894

Passengers carried, 4,627.

In addition to the above, the following statement of the principal commercial movements in the Allegheny Harbor at Pittsburg is given:

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Brick	400	Manure	16,796
Cars, loaded	415,449	Railroad ties	9,221
Cars, empty	98,424	Sand	103,291
Coal	246,632	Staves	600
Gas pipe	18,605	Vegetables	1,204
General freight	2,580		
Gravel	35,450	Total	953,408
Lumber	4,700		

Passengers carried, 27,000.

The timber and most of the lumber transported on the Allegheny River is rafted at headwaters and floated to its destination. The rafts vary in size from 50 feet by 400 feet above the Tionesta to 70 feet by 400 feet below it, and draw from 1.5 feet to 3 feet of water. The remaining portion of the lumber and nearly all other timber products, such as shingles, lath, poles, posts, bark, etc., are transported to down river points in the boat bottoms which are manufactured in the Tionesta and Clarion valleys. About 800 of these bottoms are annually built and run out of the Allegheny. They are 26 feet by 176 feet and draw from 8 inches when empty to 16 to 20 inches when loaded. Their carrying capacity is 140 tons. There are also manufactured annually in the Tionesta Valley 90 coal barges, about one-half of the number annually required by the Pittsburg coal trade. All minerals and materials other than timber products are generally transported in guypers and flats drawing from 1.5 to 4 feet and having a carrying capacity of from 75 to 200 tons. These guypers and flats are usually towed by small boats. The steamboat *Nellie Hudson No. 3*, running in the packet trade between Pittsburg and Kittanning, a distance of 45 miles, has a tonnage of 200.

CHAMBER OF COMMERCE OF PITTSBURG,
Pittsburg, Pa., July 12, 1894.

DEAR SIR: Your request for information relating to the commerce of the Allegheny River directed to the Chamber of Commerce was referred to the river and harbor committee, and speaking for that committee, I beg leave to reply as follows:

There are no officials charged with the duty of collecting the records of business done upon our rivers, and especially in the case of the Allegheny River it is difficult to obtain accurate reports of the extent and value of its commerce. The printed statements which you inclose, giving details of certain articles of commerce transported on this river, I am satisfied, after some inquiry, includes all of the leading commodities, but the quantity of some of them will vary greatly in different years; but upon the whole the statistics furnished by yourself, I believe, are reasonably correct in the sum totals for an average year.

The business of 953,000 tons for the Allegheny Harbor, which at present is only to be considered that portion made permanently navigable by back water from the Davis

Island Dam, in the Ohio, will no doubt be vastly increased in the near future following the completion of the Herr Island Dam, which will extend the navigation to numerous industrial establishments situated above the influence of the Davis Island Dam.

The undeveloped resources of the Allegheny Valley, in the opinion of the Chamber of Commerce, amply warrants an extension of the slackwater a considerable distance up the river. Some of these resources of coal and building stone never can be properly developed without the extension to them of cheaper means of transportation.

In past years the Chamber of Commerce has urged upon Congress more liberal appropriations for the improvement of the navigation of this great river. Its showing of fully 1,000,000 tons of freight per annum in its natural unimproved condition should be enough to induce the faith that a liberal expenditure here would be fully warranted by the results to be secured. The improvement of this river should not be regarded as a local matter, for the products of the Allegheny Valley are shipped to the value of millions of dollars annually to the Western and Southern States.

Very respectfully, yours,

JOHN F. DRAVO,
Chairman River and Harbor Committee.

Capt. R. L. HOXIE,
U. S. Engineer.

Bridges over Allegheny River between Pittsburg, Pa., and Olean, N. Y.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	No. of spans.	Channel span between centers of piers.	Height above low water.	When built.
	Miles.			*Feet.*		*Feet.*	*Feet.*	
Union	0.0	Highway	Wooden trussed arch (Burr).	1,060	5	212	35.1	.....
Sixth street	.5	...do	Iron bowstring truss ...	1,036	2	445	33	*1893
North side (Seventh st.).	.6	...do	Stiffened suspension iron bars.	1,080	4	330	34.8	1884
Ninth street	.7	...do	Sub-Pratt truss	1,044	5	209	34	*1892
Pittsburgh, Fort Wayne and Chicago R. R.	.9	Railroad.	Iron lattice truss	1,167	9	152	35.3	.....
Sixteenth street	1.3	Highway	Wooden trussed arch (Burr).	840	4	210	33	.....
Thirtieth street	2.4	...do	Iron truss continuous girder.	760	3	302	37.5	.....
Pittsburgh Junction R. R. (Thirty-third st.).	2.65	Railroad.	Open iron truss	841.4	4	{210.3 / 250}	{41 / }	1884
Forty-third street	3.4	Highway	Wooden trussed arch (Burr).	980	4	244	37	.....
Sharpsburg (Butler st.)	5.3	...do	Open iron truss	905	5	181	38	.....
Freeport (West Pennsylvania R. R.).	29.6	Railroad.	.....do	795	5	185	47.3	*1887
Kittanning	44.9	Highway	Iron bowstring girder ..	900	5	180	32.7	.....
Bradys Bend	69.5	...do	Open iron truss	750	4	200	36.2	*1885
Parker	83.1	...do	Iron bowstring girder ..	790	4	197	34.5	*1885
Foxburg	86	Railroad and highway.	Wooden Howe truss, decked.	530.7	3	176.9	35.3	.....
Emlenton	89.6	Highway	Open iron truss	456	2	228	36.6	*1883
Big Rock	122	...do	Wooden truss	700	4	175	27	1879
Franklin	123.1	...do	Wood and iron truss ...	711	4	175	31.5	.....
Oil City	130.2	...do	Suspension wire cables .	700	3	500	41	.....
Oil City (Relief)	130.3	...do	Iron truss	830	4	325	31.9	1893
Oil City	130.4	...do	Open iron truss	1,100	6	200	36.6	*1885
Allegheny Valley R. R.	130.6	Railroad.	Wooden trussed arch...	450	3	150	29	*1883
Tionesta	150.6	Highway	Iron bowstring girder ..	435	4	120	25.5	.....
Hickory	157.3	Railroad and highway.	Wooden Howe truss....	646	4	161.5	23.2	1883
Tidioute	165.3	Highway	Suspension wire cable ..	536	2	268	27.8	.....
Philadelphia and Erie R. R.	187.1	Railroad.	Covered wooden truss ..	450	3	150	18.6	.....
Warren	187.7	Highway	Suspension wire cable ..	452	1	452	24.4	.....
Western New York and Pennsylvania R. R.	188.1	Railroad.	Iron truss	526	3	175	18	*1889
Glade Run	189.9	Highway	Wooden Howe	568	4	142	20.2	1882
Great Bend (Western New York and Pennsylvania R. R.).	197.7	Railroad.	.....do	634	4	158.5	23.1	1882

* Rebuilt.

Bridges over Allegheny River between Pittsburg, Pa., and Olean, N. Y.—Continued.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	No. of spans.	Channel span between centers of piers.	Height above low water.	When built.
	Miles.			*Feet.*		*Feet.*	*Feet.*	
Onoville	212.4	Highway	Suspension wire cable	505	7	82	13.1	1884
Quaker bridge	218.2	...do	Wooden queen truss	300	4	75	17.5	.....
Red House	224	...do	Open iron truss	375	3	125	18.1	*1881
West Salamanca	230	...do	Open iron truss, parabolic channel span.	643	4	154	17	.....
Western New York and Pennsylvania R. R.	231.1	Railroad	Wooden Howe truss	394	3	146	19.6	1883
Salamanca	231.8	Highway	Iron parabolic truss	400	3	133½	15	1883
South Carrollton	237.8	Railroad and highway.	Wooden truss	280	6	84	17	*1883
Tuna Creek	239.9	Highway	Open iron truss	274	2	137	17	1885
Erie R. R. (Bradford branch).	240.3	Railroad	.....do	192	1	192	12.4	1883
Buffalo, Rochester, and Pittsburg R. R.	240.3	...do	.....do	203	1	203	14.1	1882
Allegany	250.6	Highway	Iron bowstring girder	400	4	100	19.4	.....
Western New York and Pennsylvania R. R.	251.3	Railroad	Wooden Howe truss	329	2	164.5	17.4	1882
Western New York and Pennsylvania R. R.	253.7	...do	Wood and iron truss	303	2	171	19.5	1885
Olean	255	Highway	Iron truss	240	3	60	16.5	.....

*Rebuilt.

Bridges authorized and not completed.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	Spans.	Channel span between centers of piers.	Height above low water.
	Miles.			*Feet.*		*Feet.*	*Feet.*
Tarentum	20	Highway.	Iron truss	951	4	306	45
Creighton	20.4	.... do	..... do	1,100	4	308	45
Kensington	20.3	.... do	..... do	1,200	4	311	45

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
Tarentum	.....	July 10, 1893	2 years from date of charter.*	5 years thereafter.
Creighton	Mar. 7, 1893.	Feb. 27, 1894		
Kensington	.....	Apr. 28, 1894		

* Company chartered by State of Pennsylvania.

E E 7.

DAM AT HERR ISLAND, ALLEGHENY RIVER, NEAR PITTSBURG, PENNSYLVANIA.

The following is a statement of the amount and date of all appropriations for this work:

August 5, 1886	$37,500
August 11, 1888	35,000
September 19, 1890	35,000
July 13, 1892	40,000
Total	147,500

The object of this dam is to begin a system of slack-water navigation
n the Allegheny River and enlarge the harbor room at Pittsburg to
ie extent of the pool formed by the dam.

The original project was for a fixed dam, but in compliance with the
quest of the authorities of Pittsburg and Allegheny City the Secre-
ry of War has ordered that the dam at Herr Island be made a mov-
ble one. This change in design necessitated a corresponding change
the estimated cost of the work. The estimate made by the late
ieut. Col. William E. Merrill was $600,000.

Much delay in commencing the work was caused by suits brought by
ie riparian owners, but by a change of location, so that the lock was
laced out 55 feet from the bank to provide access to the water front
their property, the riparian owners were satisfied and their opposi-
on was withdrawn. The land necessary for the lock and dam has
een acquired, and all legal questions as to damages to adjoining
roperty settled. Observations of the current and water levels have
een taken and borings made for the purpose of determining the char-
cter of the river bed.

During the past fiscal year the cofferdam inclosing the site for the
ock has been completed and the greater part of the necessary plant
or the construction of the lock and dam has been purchased and
eceived at the work. On the last day of the fiscal year the pumping
ut of the cofferdam would have been attempted but for defects in the
mping engine which developed under steam pressure. Temporary
ildings have been completed for shops, storehouses and office. A
ell 122 feet deep has been put down and equipped with a pump, for
rnishing drinking water to the men, a matter of considerable impor-
nce in this locality. Plans for the lock and dam have been formulated
conformity with the conclusions of the Board appointed by Special
ders No. 20, Headquarters Chief of Engineers, April 24, 1894, and
timates completed. The drawings are now in course of preparation.
ith the approval of these plans work may begin at once upon the
nstruction of the lock.

The treacherous character of the river bottom and the contraction
the waterway by encroachments upon either side have made it a
tter of some difficulty to maintain a cofferdam at this point during
gh water. Extensive repairs have been required because of injury
stained by the present cofferdam upon the occasion of two floods last
inter. It is desirable that work should be vigorously pushed for this
ason. The appropriations available will be expended in completing
e greater part of the masonry of the lock.

This work has been under the immediate supervision of Mr. J. W.
rras, assistant engineer.

[Extract from report of Mr. J. W. Arras.]

At the beginning of the year some of the materials for the cofferdam inclos-
g the lock site had been procured, and preparations were being made to put them
to place. Such other materials as were needed were immediately procured, and
July 12 the construction of cribs for protection of the cofferdam against ice
rges and freshets was commenced, and eight days later the first timbers of the
fferdam were put into position. Notwithstanding the deep water along the entire
e of the cofferdam, rapid progress on its construction was made, and on August
the timber work, except a portion of the covering, was about completed, and
ost of the gravel filling in place. When at that time it seemed improbable that
ything on the construction of the lock would be done during the remainder of
e season, the working force was reduced and the work carried on at a slower pace
til the latter part of September, when the cofferdam was entirely completed.

The total length of the cofferdam is 1,023 feet, its average height 16 feet, and its
dth between *walls 12 feet.* It was built in water varying in depth from 6 to

feet, the top of the structure being about 6 feet above the water, or Davis Island pool level.

The bank at the lower end of the dam being composed largely of loose materials, an excavation 90 feet long and extending 8 feet below the water level was made into it with a dredge in order to secure the lower arm of the dam and prevent leakage. Prior to constructing the cofferdam a row of cheap piles was driven on its inner line to steady the timber structure until sufficient gravel filling could be placed into it to keep it permanently in place.

The work of construction was performed from two coal-boat bottoms, each 26 by 176 feet, with 24-inch gunwales, one lashed to either side of the dam. These bottoms were hired at a cost of $1 per day each.

The quantities of materials expended in the construction of the cofferdam, and their cost and cost of labor, were as follows:

Articles.	Quantity.	Value.
Hemlock lumber.....feet, B. M..	203, 234	$2, 223. 45
White oak.....do....	5, 124	105. 77
Piles, driven.....number..	33	128. 04
Iron tie rods.....pounds..	49, 471	1, 096. 89
Gravel filling.....cubic yards..	7, 290	1, 458. 00
Excavation.....do....	568. 9	142. 23
Miscellaneous articles.....	.....	192. 45
Labor.....	.....	4, 859. 10
Total.....	.....	10, 2 6. 93

Usually in the construction of cofferdams for locks in this vicinity material for puddling can be secured at the site of the work; however, this could not be done here since the bank is an artificial one, being composed principally of factory refuse, such as ashes, slag, brickbats, etc.

Thirteen protection cribs, one 25 feet square, two 20 feet square, and the remainder 15 feet square, were constructed of hemlock piles well bolted together, and filled with rubble stone. Forty piles were driven at the most exposed corners of the cribs to prevent their being cut down by the ice. Their total cost was $4,558.09.

Considering the character of the river bed, which at the location of the dam is composed of light gravel and sand, and the heavy contractions of the waterway by encroachments upon it from the mainland and by the erection of the cofferdam, which together have reduced its width below the level of a 10-foot stage from 1,200 feet to little more than 600 feet, the cofferdam has stood well. The first rise of importance, which passed over it about the middle of December, caused scour to the depth of 11 feet below the river bed at the outer head corner of the dam, and slightly undermined four of the cribs and a portion of the dam, permitting 234 cubic yards of gravel filling to wash out of the latter. When the water had reached a favorable stage the space in the cofferdam was refilled with gravel, at a cost of $126.04, and to prevent further damage, 194 cubic yards of heavy bowlders were placed along the threatened parts of the dam and cribs. No further damage was sustained until May 22, when a freshet of unusual proportions, having reached a height of 26.5 feet above low water, passed over the dam. This rise caused considerable scour at all of the cribs, one of which was overturned and four others inclined to an angle of about 45° from a vertical. It also undermined the outer wall of the cofferdam at a point 75 feet below its upper end, causing 60 feet of it to rise and collapse. The repair of this break has been completed at a cost of $710.12.

A temporary building, 95 feet by 18 feet, two stories, with an annex 24 feet by 18 feet, one story, for use as blacksmith and carpenter shops, cement and tool house, etc., was erected on the lock-house lot on Twenty-second street, Pittsburg, at a cost, including numerous permanent attachments, of $670.38. A small office building was also purchased for $50.

A well 122 feet deep, for furnishing water for drinking and construction purposes, was drilled on the lot. A good supply of water, seemingly of a fair quality, was secured. The cost of the well, including a hand pump, was $180.

Two portable boilers, locomotive type, of 80-horse power capacity each, were procured for supplying steam for the pumping, hoisting, and concrete-mixing engines, and for other uses in connection with the construction work. These were erected on a crib 40 feet by 18 by 14 feet high, constructed of piles and filled with slag on the shore end of the lower arm of the cofferdam.

A 14 by 16 inch engine for driving the pumps was procured and placed in position on a crib 15 feet square, constructed on the inside of the lower end wall of the cofferdam. When put under steam pressure some defects were discovered, and the engine was returned to the parties who furnished it. The arrival of another is expected

Two 12-inch centrifugal pumps, with the necessary fittings for pumping water out of the cofferdam inclosure, were procured and have been put into place, ready for operating upon the arrival of the pumping engine.

Four iron derricks with 60-foot masts and 65-foot booms, and one iron stiff-leg derrick with 30-foot mast and 50-foot boom, were purchased. Also, four double-cylinder, 8 by 10 inch, double-drum hoisting engines. These can not be erected until the cofferdam inclosure has been emptied of water, for which everything is in readiness upon the arrival of the pumping engine.

The cost of the above plant, with the necessary fittings and attachments, was $6,852.65.

Money statement.

July 1, 1893, balance unexpended	$107,765.64
June 30, 1894, amount expended during fiscal year	29,023.05
July 1, 1894, balance unexpended	78,742.59
July 1, 1894, outstanding liabilities	3,858.33
July 1, 1894, balance available	74,884.26
Amount (estimated) required for completion of existing project	484,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., April 13, 1894.

GENERAL: I have the honor to submit herewith general plans numbered 100 and 101, respectively, showing proposed lock and movable dam to be constructed in the Allegheny River below Herr Island, and to request that so much of these plans as relates to the foundations of the lock be approved and authority given to proceed with the work of construction by the purchase of material in open market and by hired labor, this method being unquestionably, in my judgment, the most economical and advantageous to the United States. The amount available for this work at present ($87,000) will about suffice for the purchase of the necessary plant and its installation, together with preliminary work required, and the completion of the lock foundations. The general plan of the foundations would be the same for any details of construction of lock which may be decided upon.

GENERAL DESCRIPTION OF PLANS WHICH IT IS PROPOSED TO ELABORATE AND SUBMIT AS FURTHER PROJECT.

Drawing No. 100* shows the proposed location of lock and dam, and in section the general detail of the movable dam.

Drawing No. 101* shows in detail the proposed construction of the lock.

It is proposed to construct the lock mainly of concrete, using natural cement in the foundations and Portland cement in the walls. An examination of existing locks on the Monongahela River shows that the sandstone available for construction here is not a durable stone in this class of work. Experience with the Monongahela navigation works has shown the desirability of a timber sheathing for the lock chamber. It is thought that with Portland cement an artificial stone can be made of better quality than the sandstone available, and

*Omitted.

to which the oak sheathing can be readily adapted. The rectangular section of wall, without batter, is better adapted to artificial stone, and, having ample strength against water pressure, is also better adapted to resist the impact of floating objects. The guide cribs for the lock have been placed on the prolongation of the outer wall. The inner wall, ordinarily the land wall of the lock, must be placed at a distance of 55 feet from the river bank, so as to give access to the landings of adjoining owners. This throws the whole lock into the water, and it is better to take advantage of the entire space thus made available for maneuvering boats between the shore line and the prolongation of the outer wall of the lock. A further advantage of the enforced condition of this location of the land wall is taken in placing the effluent culverts in it, while the influent culverts are placed in the river wall opposite. The axis of the dam is placed opposite the lower end of the lock, so that the scour from the overflow shall not affect the lock wall; that the whole length of lock wall shall be available for the influent culverts, and that the abutment of the dam shall be at the lower end of the city landing, the use of which has been ceded to the United States for this purpose. The dam then gives pool water throughout the whole length of this landing.

The type of dam proposed is the bear trap. Experience with the Chanoine wickets at the Davis Island Dam has shown that the river drift, largely supplied by the Allegheny, seriously interferes with the working of the wickets, and that it is desirable to have some design of movable dam which can be operated more rapidly than the Chanoine wickets. From such study as I have been able to give to this matter, I have a strong impression that the bear trap can be so improved as to answer well for this locality in spans of 250 feet. It has been successfully operated with very high lifts in short spans. It will here have a lift of only 7 feet. Failures heretofore in long spans appear to have been due to very crude and primitive construction, excessive leakage, and insecure foundations. I am of the opinion that with a foundation amply secure, and with leakage practically eliminated, and with careful construction, the causes of all former failures may be removed. The cross section of dam shown in drawing No. 101 is intended to outline very generally the method of construction which I propose to study and develop. The foundation is of concrete, made abundantly strong to endure all strains, and so constructed in connection with sheet piling as to prevent any considerable passage of water beneath it. The leaves of the dam are of oak timber, the lower leaf calked on the under side. The continuous hinge of this leaf is made as nearly water-tight as possible and abundantly strong. The lower edge of the leaf is secure against flexure, being held by the hinge. The upper edge of the leaf is trussed, to give it as great resistance against flexure as possible, but the trussing is merely auxiliary. Leakage being prevented, the inflow of water to lift the leaf may be made so gradual that inequalities of pressure at different points of the span may be practically eliminated. The dam rises at first through slack water, the top of the leaf when down being from 2 to 6 feet below the water surface. This is effected by forcing air into a series of inverted open tanks of corrugated steel, made of any convenient length, and placed between the truss timbers of the lower leaf. The lifting force as shown would be about 700 pounds to the running foot, giving a large excess over the safe weight required for holding the dam down under water. Reaching the position due to this

pneumatic lift, the upper leaf projects above the surface of the water and forms the dam which is necessary for the hydraulic lift; at the same time the angle between the leaves is so diminished as to give comparative freedom of motion. The usual overflow is to be built in the influent culverts, and as additional precaution the chains which hold the upper leaf when it has risen to its full height have each a stiff spiral spring with a play of 6 inches under a pull of, say 1 ton. The crest of the dam may be raised or lowered at pleasure by maneuvering the influent and effluent gates, but a fixed position is given at, say, 2 feet below the highest point, where the leaf is held by struts resting upon the foundation. The struts are hinged to the leaf, and lift or lower by a lateral movement altogether. The bottom of the influent culvert in the piers will be below the floor of the foundation, and other precautions will be taken to prevent the entry of silt and gravel. To remove what comes in flushing may perhaps be satisfactory, but this can be supplemented by hand labor when the dam is supported upon the struts. The suppression of leakage is mainly relied upon to secure the uniform lifting of the lower leaf without serious flexure, the water entering beneath the leaf so slowly that it can be transmitted from each extremity toward the center with a slight friction head. It is expected further that ample power will be secured to overcome sliding friction of wet surfaces of iron, and that the use of rollers may be dispensed with.

A device for preventing this hurtful flexure of the lower leaf of the dam was proposed by Mr. Du Bois many years ago. This is a continuous shaft reaching from end to end of the leaf horizontally and provided with cogwheels at proper intervals; upon each of these a rack is made to work in such a way that a permanent connection is secured between the lower leaf and the foundation by means of the rack and cog wheels. If at any point of the leaf an excess of pressure occurs, this is taken up by the shaft and transmitted to other points of the leaf. A model upon this principle is now being experimented with by Mr. William Martin, assistant engineer, under the direction of Colonel Stickney, and the device may prove a valuable auxiliary. The difficulty seems to be in the difference of direction between the lifting force, which is always normal to the lower leaf, and the resistance opposed by the shaft and rack, which is always parallel to the upper leaf when the rack is attached to that leaf and the shaft to the lower leaf. When the angle between the gates is considerably greater than 90°, this resistance must approach infinity to be effective. Mr. Du Bois fastened the shaft bearings to the foundation of dam (such as it was), and the racks were hinged to the lower leaf. He had difficulty with chips, etc., which got in between the cogs and arrested the motion.

In submitting these general considerations, I desire only to inform the Chief of Engineers as to the lines upon which I am at work. Appropriations will not be available, probably, for a year or more, and there is ample time for study and experiment. At the date of transfer of this work to myself, Colonel Stickney was actively engaged and very much interested in the development of quite a novel plan for the movable dam at this site. The design was so peculiarly his own and he had given so much study to the question, while it was new to me, that I did not feel inclined to risk taking up the subject and going ahead on his plan; so it was arranged between us that I should proceed on better known lines of investigation, while he should perfect his own plan, which I would accept from him whenever ready as of the date of transfer

the work, and present as an alternative plan with whatever might be my own. This agreement I propose to carry out at some future time, when Colonel Stickney's plan is perfected, and funds become available for the work and a definite project shall be required.

Very respectfully,

R. L. HOXIE,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. O. M. Poe, Corps of Engineers, U. S. A., Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., April 16, 1894.

Respectfully forwarded to the Office of the Chief of Engineers, approved so far as relates to the foundation of the lock; but distinctly reserving an expression of opinion in regard to the material to be used in the construction of the lock walls, as well as the details of construction above the level of the lock floor. Nor am I prepared to accede to the use of the "Bear trap" for spans so great as those proposed for the dam.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April, 19, 1894.

Respectfully submitted to the Secretary of War with recommendation that a Board of Engineers, to consist of Col. Wm. P. Craighill, Lieut. Col. Amos Stickney, and Major Thomas Turtle, be constituted to consider and report upon the accompanying plans. The board to meet at Pittsburg, Pa., upon the call of its senior member. * * *

With the sanction of the Secretary the order constituting the Board will be issued from this office.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT, *April 23, 1894.*

Approved as recommended by the Chief of Engineers in the preceding indorsement.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

PITTSBURG, PA., *June 23, 1894.*

GENERAL: The Board of Officers of the Corps of Engineers constituted by Special Orders No. 20, Headquarters Corps of Engineers, U. S. Army, April 24, 1894, to report upon plans proposed for a lock

ınd dam to be constructed in the Allegheny River, below Herr Island, ıave to submit the following report:

The Board assembled at Pittsburg, Pa., on May 3, 1894, and, first ʀisiting the site of the lock and dam, took into consideration the papers ıefore it. These papers were the letter dated April 13, 1894, from Capt. ł. L. Hoxie, Corps of Engineers, the officer in charge of the work, the ıdorsements thereon, and the drawings therewith. The instructions ʀere that the Board should furnish drawings of the lock and dam proposed or adopted by them, showing location and construction of the ɔck and dam in sufficient detail to enable the local engineer to build ıem; also, an estimate of the cost. In the letter from Captain Hoxie bear-trap dam was submitted for consideration, and reference made to new type of dam upon the development of which Lieut. Col. Amos tickney, Corps of Engineers, formerly in charge of the work, was ngaged. In addition, Captain Hoxie had made recommendations in egard to constructing the lock entirely of concrete. Lieut. Col. Stickey, a member of the Board, exhibited drawings, not yet complete, of he type of dam which he had under study and elaboration.

After a consideration of all the papers before it, and of the conditions ound to exist, and of information obtained from Captain Hoxie, the Board arrived at the following conclusions:

That the width of the lock should be 55 feet.

That the foundation of the lock shall be of concrete, made with natural ɔement; the miter sills and the rests for the heel posts of the gates to ɔe of special stones of good quality.

That the material of the lock walls shall be of Portland-cement con-ʀrete, all the faces of the walls to be vertical and without sheathing ın the inside of the lock chamber.

The Board then, requesting Captain Hoxie to obtain further informaion to enable the Board to establish the length of the lock, adjourned, ɔ permit the completion by Lieut. Col. Stickney of the drawings of his ʀoposed new type of dam, and enable Lieut. Col. Stickney and Captain Oxie to prepare estimates of the cost of the new type of dam, and of a ear-trap dam, respectively.

From information derived from Captain Hoxie, in a letter dated May 1894, the Board, by correspondence, decided that the proper length of ɔck for this locality would be 330 feet between the quoins.

With the elements above given, a preliminary plan and sections of ıe lock were prepared for the Board by Captain Hoxie, with estimates ʀ cost.

A second meeting of the Board was called for June 23, 1894. Lieut. Ol. Stickney being a member of the Mississippi River Commission, ıd a meeting of that commission having been called for on the same ay, he was relieved from duty with the Board, and Maj. D. W. Lock-ood, Corps of Engineers, was appointed in his place, and appeared at he meeting of June 23.

At the second meeting the former conclusions of the Board were econsidered and assented to, and consideration of the other points ecessary to complete the recommendations for the entire structure of ɔck and dam was had. At this point it is well that the Board should xpress its opinions regarding the types of dams directly placed before ʇ for consideration, the bear trap and the system proposed by Lieut. ʃol. Stickney. The former is mentioned first, being the older.

It is very desirable that a type of dam should be devised for our ımerican rivers which will reduce or remove the difficulties attending he great quantities of drift carried by our streams, and efforts toward

the devising of such a system should be encouraged in every way practicable.

With regard to the bear trap, notwithstanding certain failures which have occurred, it is believed that it is susceptible of further and substantial development; but the Board is not prepared to recommend it for a navigable pass as wide as should be provided for the dam now under consideration. With regard to the type of dam proposed by Lieut. Col. Stickney, the Board desires to commend the great amount of work and care expended on the plans presented, and the Board would be much pleased to see an experimental trial of it on a scale of good or, better still, of full size. But, for the dam now to be presented for the approval of the Engineer Department, the Board believes that nothing but a structure of proven practicability as regards construction and operation, should be recommended.

It was concluded that the Board should recommend that the entire dam, pass, and weir should be of the Chanoine type, with trestle footbridges throughout, the pass to be 250 feet wide, and the balance of the width of the river, between the lock and the opposite shore, to be occupied by two weirs with sills at different heights; the sill of the navigation pass to be 6 feet below the level of the pool of the Davis Island Dam, the upper pool 7 feet elevation above the level of the pool of the Davis Island Dam, the sill of the length of weir next the pass to be 2 feet higher than the sill of the pass, and the sill of the second length of weir to be 4 feet higher than the sill of the pass.

It was concluded that the lock should be filled and emptied through culverts fitted with valves operated by hydraulic power, and that the gates should be of wood, all as proposed by Captain Hoxie. Other details of the lock, as concluded upon, will appear in the drawings of the lock to be prepared by Captain Hoxie at the request of the Board, and will be submitted hereafter at an early day.

There remains for consideration the closure of the space between the lock and the Pittsburg shore. The space, 55 feet in width, which, under the mutual understanding betweeen the officers of the United States and the riparian owners, is left to permit those riparian owners to have access to their landings. It is deemed advisable to have an open space in the connection between the lock and this shore, that deposits may be prevented or removed from this space. It is recommended that an opening be left in this shore connection 20 feet in width, and that this opening be closed by a Boulé dam, the sill of which shall be at the elevation of the sill of the navigation pass.

The plans for the dam, to be prepared by Captain Hoxie, at the request of the Board, will be submitted at an early day.

The estimates of cost are inclosed herewith.

Respectfully submitted.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
D. W. LOCKWOOD,
Major of Engineers.
THOMAS TURTLE,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Estimated cost of lock.

offerdam, pumps, engines, derricks, and working plant	$20,000.00
xcavation, 9,200 cubic yards, at 40 cents	3,680.00
,983 cubic yards concrete of natural cement, at $6	59,898.00
,125 cubic yards concrete of Portland cement, at $10	61,250.00
05 cubic yards cut stone, at $20	6,100.00
6,000 vitrified brick, at $12	312.00
1,000 pounds cast iron in quoins, at 2 cents	220.00
ates and miter sills	10,000.00
alves and valve frames	4,000.00
urbine	550.00
lachinery for operating valves and gates	6,450.00
4,000 feet, B. M., sheet piling, at $30	1,320.00
louses and office for lock operators	10,000.00
uide cribs, 600 feet, at $20	12,000.00
ngineering, superintendence, and contingencies, 15 per cent	29,367.00
Total	225,147.00

Estimated cost of dam.

onstruction of cofferdam, 2,500 linear feet, at $25	$62,500.00
xcavation, 9,000 cubic yards, at $1.20	10,800.00
,400 cubic yards concrete of natural cement, at $8	59,200.00
90 cubic yards concrete of Portland cement, at $12	9,480.00
ut-stone masonry, 1,460 cubic yards, at $20	29,200.00
,200 cubic yards stone paving, at $8	17,600.00
18,000 feet, B. M., white oak-timber in dam, at $60	7,080.00
3,000 feet, B. M., sheet piling, at $40	3,720.00
38,000 pounds cast iron in dam, at 6 cents	17,280.00
55,000 pounds wrought iron in dam, at 8 cents	28,400.00
54 feet of apron below dam, at $27	17,658.00
emoval of cofferdam	5,000.00
0 feet fixed dam connecting lock wall with left bank of river, at $290	29,000.00
) feet movable dam connecting lock wall with left bank of river, at $400	8,000.00
500 cubic yards stone paving for bank protection, at $8	12,000.00
ngineering, superintendence, and contingencies, 18 per cent	57,045.24
Total	373,963.24
ld cost of lock as above	225,147.00
Total cost of lock and dam	599,110.24

APPENDIX F F.

IMPROVEMENT OF FALLS OF OHIO RIVER, OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, LIEUT. COL. G. J. LYDECKER, MAJ. THOMAS H. HANDBURY, CAPT. J. G. WARREN, AND LIEUT. HIRAM M. CHITTENDEN, CORPS OF ENGINEERS.

INPROVEMENTS.

1. Falls of the Ohio River, at Louisville, Ky.
2. Indiana Chute, Falls of the Ohio River.
3. Operating and care of Louisville and Portland Canal, Kentucky.
4. Wabash River, Indiana and Illinois.
5. White River, Indiana.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 10, 1894.

GENERAL: I have the honor to transmit herewith annual reports of operations for the works in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

F F 1.

IMPROVEMENT OF THE FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

The object of the improvement now in progress is to give increased facilities to commerce passing the Falls of the Ohio River, via the Louisville and Portland Canal, by enlarging it at its upper entrance, and also at its farther end, just above the locks, in such manner as

form suitable basins, or harbors, where boats may lie and tows be properly assembled for passing through the canal and locks without interfering with the movements of other craft.

The enlargement at the entrance to the canal was commenced in 1883 and modified in 1890, as recommended by the Board of Engineers in its report dated January 28, 1890. The general width of the canal before enlargement was 90 feet; by the proposed enlargement this width will become 325 feet at the canal entrance, and from that it will gradually decrease to 210 feet at a point about 2,400 feet west of the entrance; a masonry wall 19 feet high and 2,733 feet long will limit the enlarged canal on its north, and the old north wall will be removed. Eastward of the enlarged canal, at its entrance, a basin 800 feet wide and 2,200 feet long will be constructed, the limits of the basin being a bear-trap structure 800 feet long on the west, and a concrete dam 2,800 feet long on the north. The estimate for the work included the excavation of about 325,670 cubic yards of solid rock and 270,000 cubic yards of earth, the construction of about 5,200 linear feet of new canal wall and masonry dam, and the removal of 6,200 linear feet of old canal wall, crib dikes, and timber dam.

The total work done on the improvements at the head of the canal to June 30, 1894, is as follows: Earth excavation, 212,019.31 cubic yards; rock excavation, 174,245.03 cubic yards; masonry in new canal wall, 13,678.83 cubic yards. The work yet to be done is estimated as follows: Earth excavation, 45,481.4 cubic yards; rock excavation, 136,205.69 cubic yards; masonry in new canal wall, 2,641.73 cubic yards; masonry in dam, 10,222.50 cubic yards; and bear-trap structures 800 linear feet, and the removal of 6,200 linear feet of old canal wall, crib dikes, and timber dam.

The work of enlarging the basin above the new locks was completed during the year; the operations, which are described in detail in the accompanying report of Lieut. Hiram M. Chittenden, consisted mainly in the removal of the bottom courses of the old north wall of the canal, the excavation of the underlying rock to grade, and the construction of about 50 feet of new canal wall immediately above the north pier head of the new locks.

The work accomplished in completing this portion of the improvements is summarized as follows:

Earth excavation, 141,593 cubic yards; rock excavation, 22,744.60 cubic yards; masonry built in new wall, 6,082.38 cubic yards; old wall removed, about 2,544 cubic yards.

The total amount expended under appropriations for improving the Falls of the Ohio River at Louisville, Ky., to June 30, 1894, was $723,225.72, of which the sum of $6,274.55 was expended during the past fiscal year. The cost of completing the improvements in progress, as originally estimated, will be $550,008.89.

The tabular statement of commerce embodied in Lieut. Chittenden's report on the Louisville and Portland Canal shows the extent to which commerce is concerned with these improvements. From this it appears that 1,543,367 tons of freight passed the falls by river and canal during the past fiscal year; the average for the past eight years being 2,230,637 tons annually. These figures are somewhat less than those of former years, but the decrease in tonnage during the past year was undoubtedly due to coal miners' strikes during the periods of good boating stages of the river; coal being the commodity of which the heaviest shipments are made by river.

In relation to the cost of completing the improvements now in progress, I respectfully invite attention to the recommendations of Lieut. Col. G. J. Lydecker in his report for the fiscal year 1893, as follows:

I invite attention to the fact that with small annual appropriations such cost must become far greater than if the appropriations are such as to permit a full season's work after making the very costly preliminary arrangements that must precede each season's operations; cofferdams that are built one year are carried away by the ice and freshets of winter and spring, and have to be rebuilt for the next year's work; long lines of railway have to be built at the beginning of each season and taken up and stored at its close; steam-pumping machinery brought to the work and set up, and boilers and steam piping for the steam drills set up and connected over the site of the work, and many other odd jobs attended to before any season's work can be commenced. Deducting from small appropriations the cost of this kind of work and we have little left to apply to actual work of excavation and construction; the percentage of expenditure for preliminary works and contingencies becomes in this way inordinately great, the ultimate cost of the improvement very largely increased, and the date of its completion indefinitely postponed. With such a favorable season for work as the last one was, it is especially unfortunate to be caught with only a small appropriation available for the work. I would therefore urge the importance of large appropriations for this work in future, and the next one be not less than $300,000.

The following is a summary of all appropriations made for the work up to June 30, 1894:

By the act approved—	
July 5, 1884	$300,000
August 5, 1886	150,000
August 11, 1888	150,000
September 19, 1890	60,000
July 13, 1892	60,000
Total	720,000

I inclose herewith the report of Lieut. Hiram M. Chittenden, Corps of Engineers, who was in temporary charge of these works during the period of active work, and whose report describes in detail the various operations for the fiscal year.

Money statement.

July 1, 1893, balance unexpended	$6,701.98
June 30, 1894, amount expended during fiscal year	6,274.55
July 1, 1894, balance unexpended	427.43
July 1, 1894, outstanding liabilities	161.01
July 1, 1894, balance available	266.42
Amount (estimated) required for completion of existing project	550,008.89
Amount that can be profitably expended in fiscal year ending June 30, 1896	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF FIRST LIEUT. HIRAM M. CHITTENDEN, CORPS OF ENGINEERS.

LOUISVILLE, KY., *June 30, 1894.*

CAPTAIN: I have the honor to submit the following report of operations for improving Falls of Ohio River at Louisville, Ky., during the year ending June 30, 1894:

At the beginning of the fiscal year there was available from the last appropriation the sum of $5,105.33, after deducting liabilities outstanding June 30, 1893. This balance was so small that its expenditure was carried on in conjunction with other work in progress on the Indiana Chute and on the Louisville and Portland Canal. The guiding dike at the head of the canal, from the upper extremity to its junction with the cross dam at the head of the falls, was repaired by the same working party that repaired the cross dam. The work in the canal basin at the head of the locks

was likewise carried on in connection with the laying of the water pipes across the canal, and the same cofferdam and other appliances assisted in both works. In this way we were able to accomplish a very much larger amount of work than would otherwise have been possible. The repairs of the guiding dike were commenced July 27 and completed August 17, 1893. The ice of the previous winter had torn away this structure in some places to a depth of 6 feet for a total length of 250 feet. The dike was restored to its former height and has passed the winter of 1893-'94 without injury.

About 85 feet of the wall of the new canal basin where it joins the high walls of the new locks had been left unfinished from the previous year. After the city water pipe had been laid across the canal, as described in report of operations on Louisville and Portland Canal, a cofferdam was built around the unfinished portion of the wall, both for the purpose of completing the wall and continuing the water pipe to the canal bank. This work proved very troublesome, owing to numerous angles in the cofferdam, which made it difficult to keep it clear of water. The work was begun August 10 and completed August 20.

The new canal basin at the head of the locks, though nearly completed during the previous working season, was still closed to commerce at the beginning of the fiscal year. A ledge of rock, including the old canal wall, about 720 feet long, and average 35 feet wide, and 5 feet deep, extended around the basin on the canal side, effectually closing it up. It was evident that but a very small part of this ledge could be removed with available funds if the work was to be done under water. Authority was therefore obtained to close the canal for a period of ten days, which it was believed would be long enough to thoroughly break up and partially remove the ledge. The canal could be closed only by means of a cofferdam. To economize time the framework of this dam was built on a barge ready to be launched in place as soon as the canal was closed to traffic. An earth bank was opened and the necessary material and laboring force were in place for prompt filling of the dam as soon as it was launched. This work, which was under the immediate supervision of Granville W. Shaw, U. S. assistant engineer, was effectually accomplished in about twelve hours. The dam proved absolutely tight, scarcely a barrel of water passing through it during the ten days.

Before the dam had been completed 4 steam boilers were placed along the basin wall for the operation of 12 steam drills. The drills were all put in good running order and the steam pipe gotten out and repaired. A railroad track was laid from the dump pile north of the Government stable across the grounds and down the slope into the basin. A hoisting engine was rigged up for hauling the cars from the basin, and 30 dump cars were put in service. The electric arc lights in use on the canal were relocated about the borders of the basin and 25 gasoline torches were provided in order that work might be continued at night. A day force of 200 men and a night force of 150 were employed. The work was seriously interfered with two days by rain, but its completion was not prevented. The ledge was almost entirely broken up during the ten days and about 1,000 cubic yards of rock were hauled to the dump pile. After the canal was opened the dredges were put at work, and in about eighteen days had entirely cleared away the débris, removing in all about 5,000 cubic yards of mud and rock. The canal was opened promptly on time, the removal of the dam being accomplished by the use of powder. Since November 4 the canal basin has been opened to general use. An idea of its value in the movement of traffic through the canal may be had from the accompanying photograph, which shows how it facilitates the passage of boats.

An incident of the closing of the canal was the opportunity it gave to local fishermen to drive their trade with unusual advantages. For four days the canal bottom was filled with a crowd of men and boys, wading waist deep in the foul mud, until pretty nearly every fish left in the canal had been caught. This was of the utmost importance to the work; for, as it was, the stench of the canal became so offensive before the work was completed as to threaten its discontinuance. Had all the fish remained in the canal bottom, it would probably have been impossible to continue the work the full ten days.

Since the completion of this work nothing further has been done under the appropriation except the removal of a small amount of rock from the upper section of the canal wall along the proposed enlargement at the head of the canal.

Statement of commerce and traffic, and of officers in charge of the work during the year, are contained in my report upon the operation and care of the Louisville and Portland Canal.

As the project for this work contemplates the construction of a masonry dam 800 feet long, with bear-trap openings, it was thought advisable to make a thorough study of this form of movable dam. A model was accordingly built in the shops, showing both the original bear-trap design and its later modification. It is hoped in a short time to submit the result of a study of the theory and practical app[illegible] of these gates.

No further work can be done under the general project until a new appropriation as been made, the last one being very nearly exhausted.
The following photographs are submitted with this report:
(1) Showing cofferdam around corner of canal wall.
(2) Showing ledge in canal basin before removal began.
(3) Showing frame of cofferdam for closing canal.
(4) Cofferdam in place.
(5) Canal basin just after canal was closed.
(6) Canal basin during progress of work.
(7) Canal basin just before reopening canal.
(8) Canal basin since completion. Ascending boats waiting for descending tow.

Very respectfully, your obedient servant,

HIRAM M. CHITTENDEN,
First Lieut., Corps of Engineers.

Capt. JAMES G. WARREN,
Corps of Engineers, U. S. A.

F F 2.

IMPROVEMENT OF INDIANA CHUTE, FALLS OF THE OHIO RIVER.

The main channel of the river, by which commerce passes the Falls f the Ohio when the stage of the water is such as to permit naviga- ion over them, is known as the Indiana Chute. Originally it was very rooked, with swift currents and whirls, filled with dangerous rocky oints, projecting from the sides and bottom, and navigable by skilled ilots only when the river was up to or above a stage of about 11 feet n the upper gauge of the Louisville and Portland Canal. By blasting nd removing these projections the channel has been materially nproved and straightened, and is now easily available for descending avigation when the river reaches 10 feet on the gauge, but is little ed for ascending navigation until the river becomes a foot higher cause of the strong current. When the stage of 12.7 feet on the ge is reached the locks of the canal can no longer be used, and all mmerce readily passes over the falls by river, the other river chan- ls, known as the Middle Chute and Varble Chute, being used as ll as the Indiana Chute at the higher stages of water. At extreme gh water some of the larger classes of steamers can not use the diana or Middle chutes because of the fixed spans in the bridge over em. In this case the line of navigation is via the upper portion of e canal, through the drawspan of the bridge, and thence into the er via the Varble Chute, as the passage provided for such traffic over e river wall of the canal is popularly called. A dam extends across e river at the head of the falls, from the guiding dike at the entrance the canal on the Kentucky side to the Indiana shore. Openings 500 et long and 600 feet long are provided where the dam crosses the iddle and Indiana chutes, respectively, all of the first-named open- ng and 160 feet of the last being arranged with movable dams, which ay be set up during periods of low water.

Returning now to the Indiana Chute, the project for its radical mprovement now in progress is that recommended by the board of ngineers constituted by Special Orders, No. 68, dated Headquarters Corps of Engineers, U. S. Army, November 27, 1888, in its report dated January 28, 1890. The object is to make the channel safely navigable or descending commerce when the river is not below a stage of 8 feet on he canal gauge, i. e., at a stage 2 feet below that at which tows or lar oats can safely pass at present, except by the slow route through

canal and locks. It is expected to accomplish this by the construction of dikes on the sides of the channel and by a modification of the cross dam at the head of the falls in such manner as to regulate the flow of water when the river is at the designated stage so as to establish a more uniform slope of its surface, and by the excavation of rock to secure a channel depth of not less than 8 feet below the plane of the new water surface. The principal items of work involved in the realization of this project are the excavation of about 60,000 cubic yards of solid rock, the construction of 3,700 linear feet of stone dikes, and a concrete wall 850 feet long. The exact final extent and location of the dikes and dams will be determined on further study of results produced during the progress of the work. The location of the work is such that it can be carried on with due regard to economy at periods of very low water only, and up to the end of June, 1892, operations had been limited to the removal of a comparatively small amount of rock from scattering points and reefs in the upper part of the chute from the cross dam down to the Ohio River bridge, a distance of 2,800 feet, and to repairing and raising the old crib dike on the north side of the chute, extending 575 feet downstream from the cross dam. But during the fiscal year 1893 work at all points was vigorously prosecuted throughout an exceptionally good season. Operations during the past fiscal year were limited to repairing the cross dam at the crest of the falls, the amount of funds available being too small to attempt any general work at other points.

The work accomplished to June 30, 1894, may be summarized as follows:

Rock excavation, 29,060.62 cubic yards, 1,234 linear feet of the Willow Point Dike built to an average height of 9 feet, with a top width of 40 feet, and 400 feet of the Wave Rock Dike to a mean height of 10 feet and top width of 40 feet.

To complete the work contemplated by the present project requires the excavation of some 21,212 cubic yards of rock at Willow Point and Wave Rock, the building of 35,050 cubic yards of stone dikes, 850 feet of concrete wall, 2,500 cubic yards of rock excavation at right and left hand reef. The importance of the work has been fully set forth in previous reports, and may be summarized in the statement that when the improvement is completed a large part of the commerce passing this point will be saved the delays incident to going through the canal and locks. Especially important would this be to the coal traffic, which amounts to over 1,500,000 tons annually, nearly all of which would then pass the falls by the Indiana Chute. The condition to which the work is now advanced is such that if the necessary money be made available, one season of ordinary low water will suffice for its completion, and the appropriation of $60,000, the amount required for that purpose, is earnestly recommended.

The following is a summary of all appropriations made for the work up to June 30, 1894:

By the act—

Approved July 5, 1884	$10,000
Approved August 5, 1886	20,000
Of August 11, 1888	15,000
Approved September 19, 1890	25,000
Approved July 13, 1892	35,000
Total	105,000

In addition, allotments from the general appropriations for improving the Ohio River, aggregating $95,000, were made for improving this chute [illegible] it became the subject of specific appropriations.

Money statement.

July 1, 1893, balance unexpended	$12,145.68
June 30, 1894, amount expended during fiscal year	9,483.54
July 1, 1894, balance unexpended	2,662.14
July 1, 1894, outstanding liabilities	118.20
July 1, 1894, balance available	2,543.94
Amount (estimated) required for completion of existing project	57,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	57,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

F F 3.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

Operations connected with the canal during the past year were conducted as follows: The passage of traffic and commerce was conducted by a lock operating force independent of the force used in keeping the canal in repair and making the necessary improvements. Except for short intervals during extreme low water and a period of ten days from October 5 to 15, 1893, when the canal was closed by authority of the Secretary of War for removing the bottom courses of the old north wall and underlying rock contiguous to the enlarged basin above the locks, and a short period of high water in February, 1894, the canal was open to commerce during the entire year.

The officer in charge at the close of the fiscal year, having been in charge only since June 14, has not been able to completely familiarize himself with all the details of this work, but refers to the following report of Lieut. Hiram M. Chittenden, Corps of Engineers, who has been in local and temporary charge during the entire year, for details of operation, etc., and whose views are concurred in by me.

The usual statements of traffic and commerce, and statement of expenditures, are also included.

REPORT OF FIRST LIEUT. HIRAM M. CHITTENDEN, CORPS OF ENGINEERS.

LOUISVILLE, KY., *June 30, 1894.*

CAPTAIN: I have the honor to submit the following report of operations pertaining to the care and operation of the Louisville and Portland Canal during the year ending June 30, 1894:

The allotment for operating and care of the canal during the year was as follows:

Regular force	$33,500
Extra labor	6,000
General repairs	6,000
Miscellaneous, fuel, oil, etc	7,000
New guard gates, old locks	6,000
New bridges, Eighteenth street, new locks, and old lock	28,000
Hydraulic dredge	20,000
Slope revetment above new locks	4,000
Rock excavation channel below locks	14,[illegible]
Extending city water supply to locks	[illegible]
New pavement at locks	[illegible]
Renewing slope revetment at locks	[illegible]
Contingencies	[illegible]
Total	[illegible]

REGULAR FORCE.

The "regular force" embraces the canal force proper engaged in moving traffic through the canal; the crews of the towboat and dredges, and the force in the shops, stables, and office.

The movement of traffic through the canal has gone on without interruption except for short intervals during extreme low water in August 1893, and high water in February, 1894, and a period of ten days from October 5 to 15, 1893, when the canal was temporarily closed for repairs.

The movement of coal has been particularly heavy since January last. The accompanying tables summarize the traffic for the year, both through the canal and over the falls.

COMMERCIAL STATISTICS.

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1893.

Vessels.	Number.	Capacity.
		Tons.
Passenger boats	744	268,209
Towboats	871	101,677
Government boats	342	32,475
Coal boats and barges	3,635	990,631
Small craft	260	139
Rafts	1	281
Total	5,853	1,393,554

Lockages, 2,673.

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1894.

Articles.	Tons.	Articles.	Tons.
Coal	1,153,576½	Steel rails	32,151½
Salt	3,987½	Iron, manufactured	
Oil	1,611½	Produce	3,876½
Whisky	873½	Flour	917½
Tobacco	3,483½	Sugar and molasses	10,178
Cotton	3,735½	Hay and straw	7,893
Lumber	10,608½	Live stock	6,171½
Corn	7,038½	Cement	1,534½
Wheat	4,025	Staves and shingles	43,065½
Miscellaneous	95,595		
Iron ore	3,600½	Total	1,398,770

Number of passengers, 22,260.

Statement of commerce passing the Falls of the Ohio River, via Louisville and Portland Canal and Indiana Chute, from June 30, 1887, to June 30, 1894.

Articles.	From 1887 to 1893.	From 1893 to 1894.	Total for eight years.
	Tons.	Tons.	Tons.
Coal	11,214,727	1,288,325	12,503,052
Salt	79,985	4,458	84,443
Oil	49,686	2,051	51,737
Whisky	16,433	981	17,414
Tobacco	64,765	3,739	68,504
Cotton	79,135	3,870	83,005
Lumber	2,918,434	10,734	2,929,168
Corn and wheat	76,229	11,197	87,426
Iron ore	270,904	3,602	274,506
Iron	132,005		132,005
Steel rails	271,072	32,151	303,223
Produce	51,857	3,903	55,760
Hay and straw	132,803	7,994	140,797
Flour	10,522	1,048	11,570
Stock	55,141	6,440	61,581
Sugar and molasses	55,337	10,374	65,711
Staves and shingles	264,515	48,103	312,618
Cement	20,848	1,796	22,644
Miscellaneous	537,336	102,601	639,937
Total	16,301,734	1,543,367	17,845,101

[redacted] average during past eight years, 2,230,637 tons.

ement of vessels passing Falls of the Ohio River, via Louisville and Portland Canal and Indiana Chute, June 30, 1882, to June 30, 1893.

Kinds of vessels.	1882–1893.		1894.		Total for thirteen years.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
enger boats	12,906	5,233,897	880	331,579	13,786	5,565,476
boats	14,241	1,869,044	971	118,720	15,212	1,987,764
rnment boats	1,548	112,997	342	32,475	1,890	145,472
boats and barges	51,361	16,814,797	3,877	1,065,433	55,238	17,880,230
l craft	2,651	[illegible]	260	130	2,911	137
	63		1	281	64	281
Total	82,770	24,030,742	6,331	1,548,618	89,101	25,579,360

nual average during past thirteen years: Boats, 6,853; tons, 1,967,181.

ıe towboat and dredges have been engaged during the year in the usual work of oving obstructions from the canal, and also in assisting in rock and earth excava- in the bed and slopes of the canal.

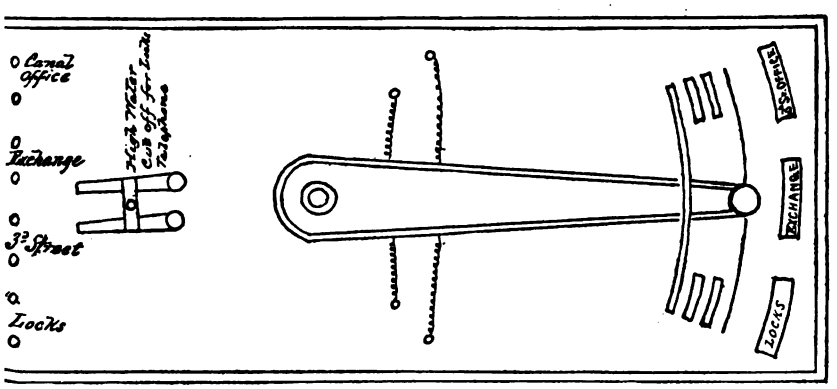
he total amount of work done during the year is as follows:

	Cubic yards.
k removed	5,000
l removed	102,200
th from slopes	4,350

he shop force has been engaged on whatever work was required to keep the canal ıt, lock gates, and buildings in repair, and to facilitate the new work which has ı in progress.

EXTRA LABOR.

he "extra labor" of the year has been mainly expended in removing projecting ı ledges from canal bottom, in grading and metaling the roads on the Govern- ıt grounds, in grading canal slopes, building fences around the Government prop- , and in constructing a telephone line from the head of the canal to the locks.



he telephone line was made necessary by the constant annoyance and interrup- with the old line. The old line was connected with the city central station, and ıed for 3 miles along streets where electric car, electric light, and city telephone ıs connected the center of town with the west end. Induction, crossing of wires, other disturbances often made the line useless at the very time when it was ıed most. These difficulties were entirely removed by the erection of a private , disconnected from the city system and available only for canal use. It is a allic circuit throughout, and is carefully "balanced;" i. e., the wires are crossed very fifth pole, so that disturbing causes neutralize each other. The line passes ıugh the canal office, where a switch board and signal bell are so arranged that office instrument may be readily connected with the city exchange, the head he canal, or the locks. The new arrangement has given entire satisfaction.

GENERAL REPAIRS.

Under this head a large amount of work was done on the towboat during the months of August and September, when she was put into excellent condition. The dredges have required a good deal of work, one of them in particular being so old and worn out as to need constant repair. It is expected during the present season to replace this dredge by a new one, for which an allotment has already been obtained. Other repair work has been done to the buildings, barges, lock gates, and wagons.

MISCELLANEOUS, ETC.

The expenditures under this head have been about the same as heretofore

NEW GUARD GATES AT OLD LOCKS.

These were built during the fall of 1893 and finally put in place January 8, 1894.

NEW BRIDGES.

On the 23d of September, 1893, a contract was made with the Louisville Bridge and Iron Company for the erection of two new iron and steel drawbridges over the Louisville and Portland Canal at Eighteenth street and at the locks, and the rerection of one of the old bridges in place of the existing bridge over the old locks. The essential features of the new bridges are as follows:

Bridge at Eighteenth street:

Length	feet..	177.07
Available width of roadway	do....	18
Maximum live load, per running foot	pounds..	1,900

Arms of unequal length.

Bridge can be easily turned by one man.

Bridge at new locks:

Length	feet..	151.1
Available width of roadway	do....	14
Maximum live road, per running foot	pounds..	1,500

Arms of unequal length.

Bridge can be easily turned by one man.

The metal used in construction of these bridges is mostly steel.

The old bridge at Eighteenth street, a Whipple truss, and one of the first iron drawbridges ever constructed, was overhauled, shortened to suit the span at the old locks, thoroughly repaired, and rerected on the new site. The work was begun in October, 1893, was carefully inspected throughout, including mill, shop, and field work, and was completed March 16, 1894.

The work of the contractors was throughout satisfactory, and in no instance gave the least cause for complaint.

The new bridges, particularly that at Eighteenth street, are a valuable improvement. At Eighteenth street the traffic is very heavy. On the old bridge vehicles could not pass each other, and only one was allowed on the bridge at a time. Now they can pass both ways without restriction as to number of vehicles. At least four times as much traffic can pass the bridge as under the old conditions.

The contract price was $17,176. The balance of the allotment was expended in necessary alterations to piers and abutments; in paving the approaches to the Eighteenth Street bridge; in building a new and substantial foundation for the bridge at the old locks; in extensive grading of the approaches to the lock bridges; and in the construction of a retaining wall to hold the slope near the approach to the bridge at the old locks. This wall holds the road embankment near the old locks from crowding the space at the head of the dry dock, which will always be of use in building lock gates, barges, etc. The wall is also taken advantage of to carry a flight of steps and a narrow-gauge railroad track from the ground at the shops down to the level of the shipyard. The total length of wall completed is 122 feet; and the number of cubic yards, 414.20.

The cost has been $7.35 per cubic yard.

It is contemplated to put an electric plant on the Eighteenth Street and new lock bridges for their more rapid operation, especially in windy weather. Plans and specifications for this work have already been prepared.

HYDRAULIC DREDGE.

Under the allotment for a new hydraulic dredge, nothing has been done further than to prepare drawings of the proposed plant.

SLOPE REVETMENT AT NEW LOCKS.

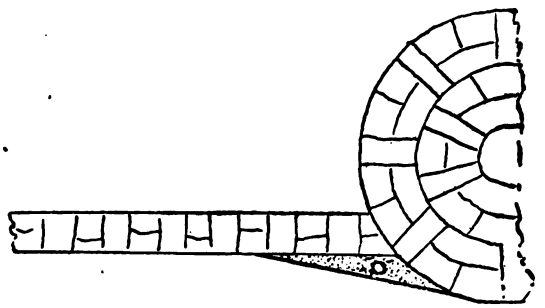
e allotment for this purpose has been entirely expended. The grading and prep-on of the slopes was done by the United States and the material and work ıvetment were purchased under contract with Mr. C. L. Cornwell, dated Sep-ıer 27, 1893. The entire work overran the special allotment, and was finally ıleted only by savings from other parts of the work. The new revetment is a tantial improvement and an important addition to the Government work.

ROCK EXCAVATION IN CHANNEL BELOW LOCKS.

is work was carried on as long as the stage of water would permit. It is being with a drill boat operating two steam drills, and is limited to the capacity of boat. Owing to the short season of extreme low water and the restricted plant, ll take three or four years to complete this work; but it is not an improvement ntly demanded by commerce.

WATER SUPPLY.

e city water supply has been extended to the Government grounds and the pipes to every important point. The only difficult feature of this work was the pas-of the canal, which had to be accomplished without the interruption of traffic. o this it was necessary to lower a length of 108 feet of pipe made up of 12-foot ths calked together in the usual way, and to get the pipe on the bottom of the l without wrenching the joints. This was done by supporting the pipe at ten ts by ropes passing over pulleys and held by counterweights. These weights adjusted to suit the strain on each rope and the pipe was lowered by simulta-sly removing a portion of the counterweight from each of the supports. An air p was used to test the pipe while being lowered. No leak whatever resulted.



was impracticable to carry this pipe under the south canal wall on account of necessary interruption to navigation which a cofferdam would have caused. eover, the south wall being laid without mortar, it would have been very diffi-to have kept a cofferdam free from water. The pipe was therefore carried up he angle between the canal wall proper and the high lock wall. It was pro-ed by an oak sheeting inclosing concrete, as shown in the figure.

Section of concrete protection over pipe.

his structure has proven of important secondary use as a fender in warding off ts from the lock wall. The pipe across the bottom of the canal has been covered a concrete to insure protection against driftwood or other substances dragging g the bottom.

NEW PAVEMENT AT LOCKS.

ıe allotment for this purpose has been entirely expended. After considerable ly of the question, it was decided by Maj. Handbury to build this pavement of ified brick, after the method used in ordinary street paving. The work was ın March 5 and completed April 12, 1894. The total area laid was re yards, and the cost, including excavation, $1.74 per yard. Tot 6.37.

SUPERVISION OF THE WORK.

The work during the year has been in charge of the following officers:
Lieut. Col. G. J. Lydecker, with Lieut. Hiram M. Chittenden in local charge, July 1 to July 20, 1893.
Lieut. Hiram M. Chittenden (temporarily), July 20 to December 8, 1893.
Maj. Thomas H. Handbury, with Lieut. Hiram M. Chittenden in local charge, December 8, 1893, to May 12, 1894.
Lieut. Hiram M. Chittenden (temporarily) May 12, 1894, to June 14, 1894.
Capt. James G. Warren with Lieut. Hiram M. Chittenden in local charge, June 14 to June 30, 1894.

GOVERNMENT RESIDENCE.

On September 6, 1893, Mr. E. M. Terry was appointed master lock manager, by order of the Secretary of War. On September 19 Lieut. Chittenden, who had been assigned by orders from Col. Lydecker to occupy the Government house at the locks, was directed by the Chief of Engineers to vacate the house and turn it over to the master lock manager. The house was accordingly vacated on September 25, 1893, and has since been occupied by Mr. Terry.

PROPOSED WORK FOR ENSUING YEAR.

The new work contemplated for the ensuing year is the construction of new guard gates at new locks; the paving of area next to the canal wall from locks to dry dock; the sodding of canal slopes; the completion of retaining wall; the rebuilding of about a thousand feet of old wall on north side of canal which has begun to fall down; the building of a new dredge; and a continuation of excavation of channel below locks.

PHOTOGRAPHS.

The following photographs are submitted in connection with this report:
(1) Government grounds in vicinity of locks of the Louisville and Portland canal.
(2) Device for laying water pipes across canal.
(3) New bridge at Eighteenth street.
(4) New bridge, new locks.
(5) Old Eighteenth street bridge reerected at old locks.
(6) Completed portion of retaining wall at shipyard.
(7) Largest coal tow ever sent down the Ohio River.
(8) Largest tow of empty coal boats ever brought up the river.

Very respectfully, your obedient servant,

HIRAM M. CHITTENDEN,
First Lieut., Corps of Engineers.

Capt. JAMES G. WARREN,
Corps of Engineers, U. S. A.

Statement of expenditures for operating and care of Louisville and Portland Canal for the year ending June 30, 1894.

Office and general administration:	
Salaries	$3,745.00
Supplies	383.53
Miscellaneous	809.65
Total	4,938.18
Canal and locks:	
Labor	38,770.47
Supplies	7,435.76
Repairs:	
Labor	1,424.92
Supplies	1,987.29
Total	49,618.44

Dredging:	
Labor	$11,587.34
Supplies	2,522.78
Repairs:	
Labor	1,428.60
Supplies	1,337.05
Total	16,875.77
New Bridges, Eighteenth street, new locks, old locks:	
Contract	17,176.00
Material	1,026.61
Labor	3,700.38
Total	21,902.99
New guard gates, old locks:	
Material	2,118.44
Labor	1,887.35
Total	4,005.79
Slope revetment at locks and above new locks:	
Contract	6,287.69
Material	100.42
Labor	1,579.07
Total	7,967.18
Rock excavation channel below locks:	
Material	122.88
Labor	1,427.76
Total	1,550.64
Extending city water supply to locks:	
Material	691.91
Labor	882.81
Total	1,574.72
New pavement at locks:	
Material	3,273.41
Labor	1,520.96
Total	4,794.37
Aggregate expenditures for the year (includes $788.55 outstanding liabilities June 30, 1894)	113,228.08

Abstract of proposals for constructing and erecting two new drawbridges and one new fixed span over the Louisville and Portland Canal, and the removal of old drawbridges and reerection of one of them, received in response to the advertisement dated August 12, 1893, and opened September 12, 1893, by First Lieut. Hiram M. Chittenden, Corps of Engineers.

No.	Name and address of bidder.	Amount of bid.	
		For entire work as specified.	For entire work as specified, less fixed span.
1	Youngstown Bridge Co., Youngstown, Ohio	$19,117	$18,165
2	Bradbury & Spencer, Oregonia, Ohio	20,240	18,050
3	Milwaukee Bridge and Iron Works, Milwaukee, Wis	23,200	21,900
*4	Louisville Bridge and Iron Co., Louisville, Ky	17,176	
5	Penn Bridge Co., Beaver Falls, Pa	21,213	
6	Pittsburg Bridge Co., Pittsburg, Pa	25,600	

* Bid of Louisville Bridge and Iron Company accepted for entire work as s

Abstract of proposals for stone revetment and masonry at the locks of the Louisville and Portland Canal, received in response to the advertisement dated August 12, 1893, and opened September 12, 1893, by First Lieut. Hiram M. Chittenden, Corps of Engineers.

No.	Name and address of bidder.	Facestone, 1,075 cubic yards (more or less), per cubic yard.	Backing, 537 cubic yards (more or less), per cubic yard.	Placing, 3,233 square yards (more or less), per square yard.	Masonry, 95 cubic yards (more or less), per cubic yard.	Total amount of bid.
*1	Charles L. Cornwell, Louisville, Ky..	$3.20	$0.90	$0.44	$4.75	$5,792.67
2	Francis J. Sweeney, New Albany, Ind.	7.50	1.70	.60	10.00	11,859.20
3	J. E. Leatherman, Louisville, Ky	3.40	.60	.27	4.75	5,835.66
4	Patrick H. Sweeney, Jeffersonville, Ind.	3.20	.90	.45	6.35	5,976.90

* Bid of Charles L. Cornwell accepted.

Abstract of proposals for furnishing and delivering coal for Louisville and Portland Canal for fiscal year ending June 30, 1895, received in response to the advertisement dated May 25, 1894, and opened by Capt. J. G. Warren, Corps of Engineers, June 25, 1894.

Kind of coal.	Quantity (more or less).	Bid of Austin H. Dugan.
Best Pittsburg lump coal.....bushels..	10,800	11 cents per bushel.
Second pool Pittsburg coal .....do....	1,000	Do.
Best Pittsburg nut coal.....do....	35,500	10 cents per bushel.
Anthracite egg coal.....tons..	5	$7 per ton.
Anthracite nut coal.....do....	5	Do.

Total amount of bid, $4,918. Bid of Austin H. Dugan accepted.

F F 4.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

The object sought by the project for improving this stream is a reliable channel with a depth of not less than 3 feet at low water from Terre Haute, Ind., to its mouth, about 250 miles below. Its improvement by the General Government was not undertaken until 1872, but before that time the Wabash Navigation Company, acting under authority conferred by the legislatures of Indiana and Illinois in 1846 and 1847, had constructed a lock and dam for passing the Grand Rapids, near Mount Carmel, Ill., at a cost of about $70,000. At the time the Government succeeded to the rights of the navigation company this lock and dam was reported as altogether unserviceable, and as having become, in fact, a greater obstruction to navigation than the original rapids. The project of improvement thereupon adopted was that submitted by Maj. G. Weitzel, Corps of Engineers, U. S. Army, in his report dated January 4, 1872, which is published on pp. 472–475 of the Report of the Chief of Engineers for 1872. This report states that in the distance of 175 miles from its mouth there are twelve points that require special improvement, and that "the whole river needs a general improvement by means of light-draft dredges and snag boats," and the estimated cost of the proposed work was summarized as follows:

1. Little Chain	$62,925.86
2. Grand Chain	28,546.70
3. Warwick Ripple	2,592.00
4. Tow-heads below New Harmony	2,222.25
5. New Harmony Cut-off	14,526.62
6. White River Shoals	3,901.03
[illegible]nd Rapids	135,000.00
[illegible]le Rock	500.00

9. Nine-Mile Ripple	$2,775.00
10. Horseshoe Bend	4,629.12
11. Swan Island	5,787.02
12. Dredging and snagging	14,400.00
	284,247.84
Add 10 per cent for superintendence and contingencies	28,424.78
Total	312,672.62

The foregoing estimate was based on a hasty survey, and subsequent surveys showed that a complete improvement of the river would require much additional work. It also contemplated the completion of the work indicated in two working seasons, and to begin with an appropriation of $175,000. The first appropriation was made by the act approved June 10, 1872, which required that the work should be commenced at its mouth, and the work thereupon commenced has been continued under subsequent appropriations. All work done prior to 1881 was between the mouth of the river up to Grayville, Ill., and by far the greater portion of it was confined to a length of about 40 miles, extending from Grand Chain to about 7 miles above Grayville. The results accomplished are summarized in the report of the officer in charge for 1891 in the statement that originally "this entire distance could scarcely be passed with a skiff at extreme low water, while at present all the usual river boats can readily and regularly make trips at all stages of the river."

The principal points which were the subject of special improvements by excavating channels through reefs, and the construction of dikes and dams to close cut-offs, secondary channels, etc., were at or near Little Chain, Grand Chain, Warwick Ripple, New Harmony, Coffee Island, Grayville, Winklers Bar, and McIntyres Bar. In addition to this special work, general snagging and dredging operations were carried on as required for keeping the river open to navigation.

The total expenditure to June 30, 1881, was $331,049.71, all of which was for work done below Mount Carmel, Ill. The act of March 3, 1881, required that one-half of the $50,000 therein appropriated should be applied to improvements above Vincennes, Ind., and since that time separate appropriations have been made for improvements above and below that place. The character of work done continued to be the same as that above indicated until 1884, when the act approved July 5, 1884, appropriated $30,000 for "improving Wabash River by lock and dam at Grand Rapids." This money was applied to a contract for furnishing a small portion of the stone required for the lock, and under subsequent appropriations the lock and masonry abutments of the dam have been completed in a most substantial manner, as described in annual reports from 1886 to 1893. During the same period considerable work was done at Grayville and New Harmony, and in removing snags from other parts of the river.

The operations on the two sections of the river during the fiscal year ending June 30, 1894, were as described below:

IMPROVEMENT BELOW VINCENNES.

The work of constructing a dam 1,100 feet long across the river at Grand Rapids was commenced July 8, 1893, and continued until November 30, 1893, when a rise in the river made it necessary to suspend operations. The work done and material used up to that date is as follows:

Excavation under foundation of dam	cubic yards..
Stone filling used in dam	do....
Timber	feet, B. M..

At the suspension of work the dam had been completed to its full height for a distance of 400 feet and to within 2 feet of its full height for a distance of 700 feet. The timber necessary for completing the dam and nearly enough of the stone filling for the cribs is on hand and will be put in place as soon as practicable. The approaches to the lock have been sufficiently cleared to permit the passage of boats, but considerable work remains to be done clearing the approaches to the lock, both from above and below, and putting in revetments and leading walls.

It is estimated that the cost of the work yet to be done is $40,000.

So far as I have been able to determine during the short period I have been in charge of this work, the navigable condition of this section of the river has not changed materially since the last annual report, and is by no means satisfactory, notwithstanding the large amount of work done on it in years past. The channels heretofore made have become badly obstructed, dikes and dams have been destroyed, new shoals have formed from the material supplied by caving banks, and for these reasons a large amount of work is required to restore the river to the condition it was in when general work was in a great measure suspended seven years ago, in order not to interfere with the earliest possible completion of the lock and dam at Grand Rapids.

The balance now available will not suffice to complete the dam, and when this is done an expenditure of about $40,000 will be required to build the necessary wing walls for covering the approaches to the lock from above and below, and putting in revetments, etc., as mentioned above. Attention is respectfully invited to the recommendation of Colonel Lydecker in his report for 1893, as follows:

> An expenditure of $50,000 on the hundred miles of river below is the least that will afford any considerable relief from its present obstructed condition. The officer in charge of this work in 1886 submitted an estimate of $160,000 (in addition to the $150,000 required for the lock and dam at Grand Rapids) as necessary for work on this section of the river. The temporary and scattered character of work done since then does not permit a reduction of this estimate below $150,000 at the present time.

Report of W. W. Duffield, assistant engineer, is submitted herewith.

The following is a summary of all appropriations made for the work up to June 30, 1894:

By the act—		By the act—	
Approved June 10, 1872	$50,000	Approved August 2, 1882	$40,000
Approved March 3, 1873	50,000	Approved July 5, 1884	30,000
Approved June 23, 1874	25,000	Approved August 5, 1886	60,000
Approved March 3, 1875	40,000	Of August 11, 1888	60,000
Approved August 14, 1876	70,000	Approved September 19, 1890	60,000
Approved June 18, 1878	50,000	Approved July 13, 1892	60,000
Approved March 3, 1879	20,000		
Approved June 14, 1880	25,000	Total	665,000
Approved March 3, 1881	25,000		

Money statement.

July 1, 1893, balance unexpended	$45,167.79
June 30, 1894, amount expended during fiscal year	44,858.19
July 1, 1894, balance unexpended	309.60
July 1, 1894, outstanding liabilities	80.00
July 1, 1894, balance available	229.60
Amount (estimated) required for completion of existing project	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. W. W. DUFFIELD, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1894.*

CAPTAIN: I have the honor to submit the following report of work done on the Wabash River improvement below Vincennes, during the fiscal year ending June 30, 1894:

The work done on this improvement has been the construction of the dam across the Wabash River at Grand Rapids, two and a half miles above Mount Carmel, Ill.

This work was begun July 8, 1893, and continued until November 30, 1893, but the rapid rising of the water prevented its completion. The work still to be done consists of filling in the stone and placing the sheeting on the central portion of the dam.

DAM.

The dam is 1,100 feet in length. It consists of timber crib work filled with stone and the work done and materials used in its construction are as follows:

Excavation under foundation of dam	cubic yards..	3,600
Excavation by dredge of approaches to the locks	do....	4,826
Timber above water	feet B. M..	731,982
Timber under water	do....	222,858

CONDITION OF THE RIVER.

The present stage of water is very low, so that all navigation is impossible.

OBSTRUCTIONS.

The obstruction at Ribayeres Island below New Harmony still continues. The cut-off is constantly increasing in depth and the great volume of water has abandoned the original channel and now flows through the cut-off. Were this channel unobstructed no great harm would result, but unfortunately it is filled with massive bowlders which render navigation not only dangerous, but absolutely impossible. The original channel will soon be drained so that there will not be a sufficient depth for navigation of any description, except during periods of high water.

RIVER TRAFFIC.

But two steamers ply on this portion of the river. These are—

	Tons.
Peankishaw	164$\frac{88}{95}$
Diana	14$\frac{32}{95}$

Both boats are transitory ones, without either definite starting points or termini. They carry no freight, but each has a barge in tow for the carriage of passengers on picnics or excursion trips.

The soil of the Wabash Valley is a rich alluvium, admirably adapted for the growth of grain and grass. Hence, its great staples are wheat, corn, and cattle. Were the Wabash River the only outlet for these staples the river traffic would be enormous. But such is not the fact. Each year the river traffic has constantly decreased until now there is little or none left. None of the large towns through which the Wabash River flows have any established lines of steamers for either passengers or freight; no elevators for grain; no platforms for loading cattle, and no wharf boats or other means of receiving and discharging either passengers or freight. The cause of this lack of river traffic is not difficult to find. The Wabash improvements were begun by a joint commission of the States of Illinois and Indiana at an early day, before railways were known, or their great carrying power understood, and when river traffic was the sole mode of transportation. But since then a vast network of railways have crossed the entire Wabash Valley between Terre Haute and the mouth of Wabash River. Eight great through lines of railway cross this stream between Terre Haute and its mouth. The Springfield branch of the Ohio and Mississippi Railroad has its southern terminus on the Ohio River at Shawneetown, 6 miles below the mouth of the Wabash River. The Cincinnati, Cleveland, Chicago and St. Lo[illegible] (Big Four) follows the right or Illinois bank from Grayville, 17 miles below Mc[illegible] Carmel to West Fork, 18 miles below Terre Haute, and the Terre Haute and E[illegible] ville Railroad follows the left or Indiana bank from Terre Haute to Vin[illegible] These numerous railways have monopolized the transportation of the entir[illegible] Valley and left nothing whatever for the river traffic.

PROJECT.

Should additional appropriations be made it is intended to complete the dam at Grand Rapids, and the estimated cost of such completion will be as follows:

Completing locks:	
Dredging approaches—	
Dredge, one month	$550.00
Dumping scow crew, one month	320.00
Coal, oil, etc	100.00
Leading walls at head and foot of lock—	
2 leading walls, 151 feet long, 15 feet wide, 15 feet high 2 leading walls, 121 feet long, 15 feet wide, 15 feet high	15,269.00
Completing dam:	
2,100 cubic yards of stone filling (stone already quarried)	2,100.00
Iron still required	150.00
Labor	900.00
Revetment wall immediately below abutment, 121 feet long, 12 feet wide, 15 feet high	3,300.00
Removing driftwood lodged on dam	400.00
Total	23,069.00
Add 10 per cent for contingencies	2,308.90
Total	25,397.90

The last item in the above estimate covers removal of a mass of driftwood lodged on the dam near the left or Indiana bank of the river.

Very respectfully, your obedient servant,

W. W. DUFFIELD,
Assistant Engineer.

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

IMPROVEMENT ABOVE VINCENNES.

Operations on this section of the river were limited to removing snags for a short season, from April 14 to May 30, 1894. The navigable condition of the portion of the river covered by these operations was very much improved. There are, however, several other points in the river where snagging and other improvements are very much needed.

An annual expenditure of about $5,000 will be necessary to keep this portion of the river free from snags. Besides this, channels should be dredged at several points, a few dams built to close secondary channels, and shore protection put in at several points along the banks from which large amounts of sand are annually washed into the river, supplying thereby the material by which the bars are formed. This is about all that could be done in the way of improvement unless an extensive system of work, whose cost would be out of all proportion with the present commerce of the river, should be undertaken. The cost of the work above suggested as being highly desirable is estimated at $20,000.

The report of Mr. W. W. Duffield, assistant engineer, is transmitted herewith.

The following is a summary of all appropriations made for the work to date:

By the act—	
Approved March 3, 1881	$25,000
Approved August 2, 1882	30,000
Approved July 5, 1884	10,000
Of August 11, 1888	5,000
Approved September 19, 1890	5,500
Approved July 13, 1892	5,000
Total	80,500

Money statement.

ıly 1, 1893, balance unexpended	$2,262.34
ıne 30, 1894, amount expended during fiscal year	1,711.86
ıly 1, 1894, balance unexpended	550.48
ıly 1, 1894, outstanding liabilities	6.85
ıly 1, 1894, balance available	543.63
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. W. W. DUFFIELD, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1894.*

CAPTAIN: I have the honor to submit the following report of work done on the abash River improvement above Vincennes during the fiscal year ending June 30, 94:

The work done has been the removal of snags in this portion of the river. As soon the river was free from ice the snag boat *Osseo* began removing snags between rre Haute and Hutsonville, with the following results:

Month.	Snags removed.	Tons.
ril, 1894	27	132.2
y, 1894	50	235.2
Total	77	367.5

The appropriation for this improvement being nearly exhausted, the snag boat *seo* was recalled and dispatched to White River, where she has been engaged in e same duty for month of June, 1894.

CONDITION OF THE RIVER.

The present stage of water is very low, so that all navigation is impossible.

RIVER TRAFFIC.

Each successive year the traffic of the river has constantly decreased, until now ere is little or none left. But two small steamers ply on this portion of the river, ıose names and tonnage are as follows:

	Tons.
ankishaw	164$\frac{44}{100}$
lcon	134$\frac{17}{100}$

Both these boats are transitory ones, without either definite starting points or mini. They carry no freight, but each has a barge in tow for the carriage of ssengers on picnics or excursion trips.

COMMERCIAL STATISTICS.

The only traffic on the river other than that of the above-named steamers consists an occasional small raft of logs whose greatest diameter does not exceed 12 :hes, used exclusively by the manufacturers of wooden ware.

PROJECT.

Should future appropriations be made, it is the intention to continue the removal snags by the steamer *Osseo*.

Very respectfully, your obedient servant,

W. W. DUFFIELD
Assistant En

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

F F 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The first appropriation for the improvement of this river was made by the act approved March 3, 1879, the object being to obtain a navigable channel with a minimum low-water depth of about 2 feet, which would permit navigation by boats drawing no more than 3 feet throughout most of the year. The work has consisted in the excavation of channels through rocky reefs and gravel shoals, the removal of snags and overhanging trees, the construction of dams and dikes for channel contraction, and the protection of banks where necessary. The principal obstruction originally was a long rocky reef known as Kelly's Ripple, a short distance above the mouth of the river. A channel has been excavated through this reef with a clear width of 150 feet at its upper end, gradually narrowing to a uniform width of 75 feet for a length of about half a mile. The bottom of the channel is 3 feet below the plane of low water, and the material excavated was used to form lateral guiding dikes.

The snagging operations in progress at the beginning of the fiscal year were continued until September 12, 1893, when the water became too low to move the boat. On October 27 operations were resumed and continued until November 30, when the boat was brought back into winter quarters. The boat was sent back on this work in June, 1894, and has remained in commission on the river until the end of the year. During the year 421 snags, weighing 2,229.6 tons were removed from the river. The small balance available will render the discontinuance of these operations imperative before the end of the season, unless a new appropriation becomes available.

The report of Mr. W. W. Duffield, assistant engineer, is transmitted herewith.

The following is a summary of all appropriations made for the work up to June 30, 1894:

By the act—	
Approved March 3, 1879	$25,000
Approved June 14, 1880	20,000
Approved March 3, 1881	20,000
Approved August 2, 1882	20,000
Approved July 5, 1884	10,000
Approved August 5, 1886	7,500
Of August 11, 1888	5,000
Approved July 13, 1892	5,000
Total	112,500

Money statement.

July 1, 1893, balance unexpended	$7,691.81
June 30, 1894, amount expended during fiscal year	4,709.49
July 1, 1894, balance unexpended	2,982.32
July 1, 1894, outstanding liabilities	1,069.50
July 1, 1894, balance available	1,912.82
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	7,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. W. W. DUFFIELD, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1894.*

CAPTAIN: I have the honor to submit the following report of work done on the White River improvement during the fiscal year ending June 30, 1894.

The work done has been the removal of snags in White River, as follows:

Month.	Snags removed.	Tons.
September, 1893	161	884.6
November, 1893	135	727.2
June, 1894	125	617.8
Total	421	2,229.6

CONDITION OF THE RIVER.

The present stage of water is very low, so that all navigation is impossible.

RIVER TRAFFIC.

Each successive year the traffic of the river has constantly decreased, until now there is little or none left. But one small steamer, the *Irene*, of $17\frac{68}{95}$ tons, makes occasional trips up the river. This is a transitory boat without any definite starting points or termini, towing a barge of the same tonnage as herself, but carries no freight whatever, the barge being used solely for the carriage of passengers on picnics or excursion trips.

COMMERCIAL STATISTICS.

The only traffic on the river other than that of the steamer *Irene*, above mentioned, consists of an occasional small raft of logs, whose greatest diameter does not exceed 12 inches, used exclusively by the manufacturers of wooden ware.

PROJECT.

Should future appropriations be made it is the intention to continue the removal of snags by the steamer *Osseo*.

Very respectfully, your obedient servant,

W. W. DUFFIELD,
Assistant Engineer.

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

APPENDIX G G.

IMPROVEMENT OF GREAT KANAWHA, ELK, AND GAULEY RIVERS, WEST VIRGINIA, AND OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Great Kanawha River, West Virginia.
2. Operating and care of locks and dams on Great Kanawha River, West Virginia.
3. Elk River, West Virginia.
4. Gauley River, West Virginia.
5. New River, Virginia and West Virginia.

(For letter of transmittal see Appendix I.)

G G 1.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year round throughout the whole river, 96 miles. The means are locks and dams. The locks are about 300 by 50 feet above Charleston and about 340 by 55 feet below. The following table shows the present condition:

No.	Distance from Charleston.	Style of dam.	Completed in—	Remarks.
2	26 miles above	Fixed	1887	In operation.
3	21 miles above	do	1882	Do.
4	15 miles above	Movable	1880	Do.
5	9 miles above	do	1880	Do.
6	4 miles below	do	1886	Do.
7	14 miles below	do	1893	Do.
8	22½ miles below	do	1893	Do.
9	32 miles below	do		Under contract for completion.
10	39½ miles below	do		Do.
11	56¾ miles below	do		Do.

Some dredging is also necessary in some of the pools, as well as the occasional removal of snags and rocks. It is expected the improvement will be completed in 1896.

Mr. A. M. Scott has continued to exercise the local charge in his usual efficient manner. His report, which is appended, treats in detail of the operations of the year.

As the improvement of the river has progressed the commerce on it, notably the shipment of coal, has greatly increased.

The telephone line has been maintained between the central office in Charleston and the locks, and it is used by night as well as by day, being found indispensable for the proper oversight and direction of the operations, as well of construction and of maintenance.

A gauge reader has been kept at Kanawha Falls, near which place the Gauley joins the New to form the Great Kanawha River, and another at Hinton, where the Greenbrier empties into the New River. The compensation of these men is less than $10 a month each. They send to the central office daily reports by postal card of the stage of the river at their respective stations and by telegraph when there is a rapid rise. These reports are necessary as warnings to the central office in Charleston, in order that such maneuvers of dams, etc., may be had in time as the height and duration of the freshet may require.

The following are the amounts and dates of appropriations for improving Great Kanawha River, West Virginia:

March 3, 1873	$25,000	July 5, 1884	$200,000
June 23, 1874	25,000	August 5, 1886	187,500
March 3, 1875	300,000	August 11, 1888	350,000
August 14, 1876	270,000	September 19, 1890	300,000
June 18, 1878	222,000	July 13, 1892	225,000
March 3, 1879	150,000	March 3, 1893	500,000
June 14, 1880	200,000		
March 3, 1881	200,000	Total	3,354,500
August 2, 1882	200,000		

Money statement.

July 1, 1893, balance unexpended		$730,976.76
June 30, 1894, amount expended during fiscal year		254,350.05
July 1, 1894, balance unexpended		476,626.71
July 1, 1894, outstanding liabilities	$4,000.00	
July 1, 1894, amount covered by uncompleted contracts	880,602.52	
		884,602.52
Amount (estimated) required for completion of existing project		580,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		580,700.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for building a lock house at site of Lock and Dam No. 11, opened at U. S. Engineer's Office, Charleston, W. Va., at 3:10 p. m. September 21, 1893.

Kind of work and materials.	No. 1.—Martin V. Smith, Charleston, W. Va.		No. 2.—James M. Mays, Charleston, W. Va.		No. 3.—Norris S. Stark, Charleston, W. Va.		No. 4.—Henry Crawford, St. Albans, W. Va.		No. 5.—DeBord & St. Clair, Charleston, W. Va.	
	Bid.	Amt.	Bid.	Amt.	Bid.	Amt.	Bid.	Amt.	Bid.	Amt.
1 lock house and outbuilding	$1,100.00	$1,100	$2,100.00	$2,100	$1,799.00	$1,799	$1,760.00	$1,760	$1,780.80	$1,780.80
70 cubic yards masonry (approximate)	6.00	420	5.00	350	4.00	280	5.00	350	4.75	332.50
80 cubic yards excavation (approximate)	.30	24	.35	28	.30	24	.30	24	.25	20.00
16 pier stone (approximate)	5.00	80	3.00	48	3.00	48	1.50	24	1.50	24.00
Total		1,624		2,526		2,151		2,158		2,157.30

Available for the contract, $1,900. Contract with Martin V. Smith.

bstract of proposals for ironwork for Locks Nos. 9, 10, and 11, Great Kanawha River, opened at Charleston-Kanawha, W. Va., at 3:05 p. m., May 23, 1894.

Kinds of material.	Approximate quantities.	No. 1.—Pittsburg Forge and Iron Co., Pittsburg, Pa.		No. 2.—The Van Dorn Iron Works Co., Cleveland, Ohio.		No. 3.—Samuel M. Livingston and Jacob Weisberg, Cincinnati, Ohio.	
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.
	Pounds.	*Cents.*		*Cents.*		*Cents.*	
rought iron	16,000	14¾	$2,360.00	3.6	$576.00	7.8	$1,248.00
ast iron	10,300	2	206.00	2¼	231.75	1.8	185.40
Total			2,566.00		807.75		1,433.40

nds of material.	No. 4.—G. M. Stanwood & Co., Portland, Me.		No. 5.—The Fred J. Meyers Manufacturing Co., Hamilton, Ohio.		No. 6.—Scaife Foundry and Machine Co., Limited, Pittsburg, Pa.	
	Bid.	Amount.	Bid.	Amount.	Bid.	Amount.
	Cents.		*Cents.*		*Cents.*	
rought iron	5.3	$848.00	9¼	$1,480.00	10	$1,600.00
ast iron	2¾	244.63	4¼	437.75	2	206.00
Total		1,092.63		1,917.75		1,806.00

Contract with the Van Dorn Iron Works Co., dated June 8, 1894, but not approved by the Chief of ngineers up to June 30, 1894, on account of informalities which are in process of settlement.

REPORT OF MR. ADDISON M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 3, 1894.

COLONEL: I have the honor to submit the following report on the Great Kanawha iver improvement for the year ending June 30, 1894:

The most important work on construction during the year was the completion of ocks and Dams Nos. 7 and 8, and the beginning of Nos. 9, 10, and 11, the last required carry the improvement to the mouth of the river.

COMPLETING LOCKS AND DAMS NOS. 7 AND 8.

These two locks and dams, which had been under construction about four years—o. 7 was begun in the spring and No. 8 in the fall of 1889—were completed and ut in operation in October. The foundations and masonry of both of these works, s described in the last annual report, were finished early last season. The building of the lock gates, and of the ironwork and wickets for the dams was also well dvanced by July 1. After this the lock gates were finished, launched, and hung, he ironwork and wickets of the dams completed and put in place, service boats itted up, etc., and both works considered "in operation" on October 10. No. 7 dam was entirely put up for the first time on the 10th and 11th, and No. 8 on the 11th nd 12th of that month. An account of Nos. 7 and 8 since October 10 will be given nder the head of "Operating completed works."

Both dams are of the Chanoine wicket type, operated throughout from trestle ervice bridges. Descriptions of both works have been published in your recent nnual reports to the Chief of Engineers. Full detailed drawings with descriptions f Lock and Dam No. 7, and a general history and description of the whole improvement were published by the Engineer Department in 1892. (Report of the Chief f Engineers for 1892, part 3, pp. 2044–2053, etc.

Movable irons for Dams 7 and 8.—This contract with the Fred J. Meyers Manufacturing Company, of Covington, Ky. (made in June, 1892), and which included all the ironwork for the movable parts of both dams, and some extra bridge trestles r Dams Nos. 4, 5, and 6, was nearly completed at the beginning of the fiscal year. he last of the irons, completing the contract, were delivered in September.

Irons for lock gates.—The contractors for the ironwork for the lock gates at 7 and H. T. Morrison & Co., Petersburg, Va., were so slow that you refused to recommend an extension of the contract after August 1 (the contract had already been

extended four times), and it expired on that day. At that time the work had all been delivered except the journal straps, double U links and gibs and keys for the upper fastenings. These were procured in open market from the Scaife Foundry and Machine Company, of Pittsburg, in August.

Chains.—The special chain and clevises required for the wickets and trestles of Dams 7 and 8, procured by contract with the West End Rolling Mill Company and Chain Works of Lebanon, Pa., dated April 20, 1893, were all delivered at the dams in September.

Lock gates, wickets, etc.—The lock gates and wickets for the Dams 7 and 8, were built at the sites and put in place by hired labor. At the beginning of the year, July 1, the principal framing of the gates was finished and the assembling and ironing had begun. They were completed, launched, and hung, the last gate being swung at No. 8 on September 28. The gates were built on the top of the bank, let down into the river on skids, towed under a boat to the recesses, and raised by crabs placed on the walls. Each leaf weighs about 37½ tons. Lock 7 gates (those at No. 8 are essentially like them) are described on p. 2060 of the Report of the Chief of Engineers for 1892.

The wickets were finished, except putting in the panels, July 1. They were finished and hung, and all the movable irons placed in July, August, and September. The wicket horses and bridge trestles of the navigation passes were secured to their boxes by divers. In placing the irons on the pass a considerable amount of material, gravel, stone, etc., had to be removed by hand or hand scrapers. This work was considerably delayed in September by high water.

The completion of these two locks and dams adds 18½ miles to the slack water. They overcome troublesome parts of the river and are, in themselves, very important to navigation, to the coal business particularly. A decided advantage is gained in towing by dropping barges, about as they are loaded, down into the No. 8 pool, or into the naturally deep water just below Lock 8, and holding there for a rise, instead of farther up the river. Coal and towboat men have been prompt to avail themselves of this. Several of the largest operators, seeing the importance of it, have recently leased ground for landings in the neighborhood of Lock 8.

LOCK AND DAM NO. 9—CONSTRUCTION OF.

[Movable dam, 25 miles from mouth of river and 33 below Charleston.]

The contractors for the foundations and masonry of Lock and Dam No. 9 began work the last of June, 1893. Dredging for the cofferdam for the lock was begun June 30. The first crib for the cofferdam was sunk July 7. The work of building the coffer was energetically pushed, and was so far advanced that pumping was started August 25. Excavation inside was begun August 28, but was stopped on the 30th by a sudden rise in the river which did some damage to the unfinished coffer. This was repaired so that the pumps were started again September 7. It proved a bad fall for work, the coffer being filled by rises and pumped out four times during September and October. The laying of masonry began November 10, and was continued with a small force when the weather would admit until December 2, when operations in the coffer were suspended for the winter.

The lock cofferdam was pumped out, for the first time this season, early in May, beginning on the 2d, but the laying of masonry was not resumed until the 18th. The cofferdam has been flooded once since then by high water. The laying of masonry has been going too slow, but the contractors are getting in shape to move it faster.

At the present time the bottom course of the river wall is in and the two courses on top of it, required to bring this wall up to the top of miter sill, are about half set. The quantities are given in the table below.

Fairly good progress has been made in quarrying and preparing stone for the work. All the stone for the front work, except the hollow quoins and corners for the lock walls, is quarried at Sattes, just above Lock 7 and brought to the site by the Kanawha and Michigan Railroad. The hollow quoins and corners are quarried on Elk River about 1 mile from Charleston. The greater part of the backing comes from quarries close to the site. This last stone is not hard enough for the face work.

The following are the items of work done on the contract during the year:

Crib logs in cofferdam	linear feet..	49,478
Sheathing in cofferdam	feet, B. M..	29,340
Filling in cofferdam	cubic yards..	7,559
Excavation, including dredging	do....	10,717
Rock face masonry in place	do....	380
Pointed face masonry in place	do....	17
Backing masonry in place	do....	497
Concrete in place	do....	22
S[illegible]or rock-face masonry, cut and delivered in yard	do....	618

Stone for pointed-face masonry, cut and delivered in yard	cubic yards	563
Stone for cut-stone masonry, cut and delivered in yard	do	121
Stone for sills, cut and delivered in yard	do	71
Stone for quoins, cut and delivered in yard	do	10
Stone for coping, cut and delivered in yard	do	18
Stone for backing masonry, cut and delivered in yard	do	2,995
Stone for concrete, broken and delivered in yard	do	360

The cofferdam for the lock is 542 feet long up and down stream with shore ends 114 feet each, making a total length of 770 feet. The top of the coffer is 12 feet above low water reference and from 20 to 22 feet above bed rock. It is made of rough cribs 15 feet wide, sunk in 21-foot sections to bed rock, filled with dredged material, sheathed on the outside with inch boards, and banked with clay and gravel. The banking and filling are protected from washing with a layer of rough stone. It leaks very little and is a good, strong coffer.

LOCK AND DAM NO. 10—CONSTRUCTION OF.

[Movable dam 19 miles from mouth of river and 39 miles below Charleston.]

The contractors for the foundations and masonry of Lock and Dam No. 10 (Zimmerman, Truax & Sheridan, the same firm that has Lock and Dam No. 9) began work at the site, grubbing and clearing the bank in July. Owing to delay in getting a dredge excavation for the lock, cofferdam was not begun till August 25. The building of the coffer was begun September 6. It was not carried on with much energy and was also a good deal delayed by high water. At the close of the season the coffer was practically finished except the lower shore end, which was left open to admit the dredge to finish the dredging proposed inside. This dredging was resumed April 3 and finished on the 20th. The cofferdam was near enough completion to admit of starting the pumps May 16. The coffer was flooded by the rise of the 22d, and the pumps were not started again till May 30. Excavation inside began June 4. The cofferdam for this lock is of the same style as for Lock 9, described above. It is the same height above low water as the No. 9 coffer (12 feet) but is not so high from bottom owing to the relative difference in elevation of bed rock (see Report of Chief of Engineers for 1893, p. 2588). The coffer is 600 feet long up and down stream with shore ends 125 and 115 feet. The coffer cribs are 14 feet wide and generally about 17 feet high from bed rock. This is also a good cofferdam and leaks but little.

The contractors were slow about getting derricks, tracks, etc., in place to begin the masonry. The first stone was not set till June 24, and as shown below only a few yards (in bottom course of river wall) have been placed yet. Arrangements for better progress at setting are now nearly complete.

Rather slow progress has been made on this contract, too, at preparing stone. The quantity got out, quarried, and cut, is given below. The stone for No. 10, except part of the backing got near the site, are quarried at the Sattes and Elk quarries in connection with that for No. 9 and brought to the site by rail.

The following are the items of work done on this contract during the year:

Crib logs in cofferdam	linear feet	42,860
Sheathing in cofferdam	feet, B. M.	28,400
Filling in cofferdam	cubic yards	6,395
Excavation, including dredging	do	8,280
Rock excavation	do	28
Rock-face masonry in place	do	4
Pointed-face masonry in place	do	3
Backing masonry in place	do	10
Sills	do	2
Stone for rock-face masonry, cut and delivered in yard	do	307
Stone for pointed-face masonry, cut and delivered in yard	do	224
Stone for cut-stone masonry, cut and delivered in yard	do	32
Stone for sills masonry, cut and delivered in yard	do	10
Stone for coping, cut and delivered in yard	do	19
Stone for backing masonry, cut and delivered in yard	do	1,242
Stone for concrete, broken and delivered in yard	do	154

LOCK AND DAM NO. 11—CONSTRUCTION OF.

[Movable dam 1¾ miles from mouth of river, 56¼ miles below Charleston and 88¾ below head of slack water.]

The contractor for the foundations and masonry of Lock and Dam 11, Mr. Thomas Munford, began the work in July. He has employed a large force whenever practicable all the year and has made good progress. Dredging for the cofferdam for

lock was begun July 5. The first crib for the coffer was sunk July 24. The building of the cofferdam was prosecuted with energy, except when interrupted by high water, during the rest of the season. Excavating for the site of the coffer was carried on by two dredges, and was in progress the greater part of the time, night and day. The coffer was practically completed in November, but owing to the lateness of the season was not pumped out.

The cofferdams at this site form a difficult and a very expensive part of the work owing to the depth to and the great amount of excavation necessary to get to suitable foundation. This first coffer is on hardpan from 17 to 18 feet below low water. The top is 12 feet above low water, making it from 29 to 30 feet in height. To get the coffer to hardpan, from 12 to 18 feet in depth of material had to be dredged; this was mostly a fine sand that ran a good deal, necessitating flat slopes and wide excavations. The coffer is built of cribs 19 feet wide, filled, sheathed, and banked in the general style described for Lock 9. It is 575 feet long up and down stream with shore wings 140 and 125 feet, making a total length of 840 feet.

Pumping the coffer began May 16. The water was about out on the 21st, when the work was flooded by a rise, mainly from the Ohio, that reached 28 feet above low water on the 24th. The river fell so that pumping was resumed June 5. The water was nearly all out again June 8 when a leak started under one of the cribs (caused by its not being well down to hardpan), and it was necessary to stop the pumps. The weak place was repaired by driving heavy sheet piling, on the outside next to the sheathing with a pile driver and refilling the cribs. The pumps were started again June 14. Excavation began inside on the 16th, and was continued night and day until the 24th, when another bad leak developed from the same cause as the first and the coffer filled. This was repaired and the pumps started again June 29.

Large forces were employed in the quarries and stone yards nearly all the year, and rapid progress made in the preparation of material. The quantities prepared and delivered are given below. The face stone (except for hollow quoins and lock corners which come from on Elk) and the stone for concrete are from quarries between Locks 6 and 7 and are brought to the site by rail, the Kanawha and Michigan having a switch nearly a mile long for the purpose. The stone for backing are mostly taken from the bluff on the lock side close to the site.

This contractor has an exceptionally good plant; some of the important parts of it are referred to below.

The materials are taken from the main yards on the abutment side across the river to the lower end of the lock coffer and to the center of the dam clear across by a hoisting cableway, said by the manufacturers (the Lidgerwood Company) to be the largest of the kind yet constructed. The main cable is 2¼ inches in diameter and 1,900 feet long; distance between towers, 1,505 feet. One of the towers is 100 feet and the other 40 feet high, the latter being on the bluff referred to. The lowest part of the cable, without load, is 94 feet above low water, and it can, if necessary, be raised somewhat higher. The power is a double 10 by 12 engine; maximum load provided for, 4 tons. The carrier is traversed, either loaded or light, about 800 feet per minute, and is raised and lowered at about half that speed. Up to the present time the cableway has worked very satisfactorily.

The specifications require work in the cofferdams at this place to be carried on night and day, and an electric plant for 12 arc lights of 2,000-candle power each has been put up at the site. It was in operation part of the time last fall when the dredging for and building the cofferdam was underway.

A concrete mixer of the ordinary cubical box pattern, but of unusual size, the box being 5 feet each way, has just been erected. It will be run by a 12 by 16 engine, and is intended to rapidly mix a batch not smaller than our regular one (stone, 33 feet; sand, 15 feet; cement, 2 barrels) which makes about 36 cubic feet of concrete in place.

The items of work done on this contract during the year are as follows:

Crib logs in cofferdam	linear feet..	80,000
Sheathing in cofferdam	feet, B. M..	39,000
Filling in cofferdam	cubic yards..	13,000
Excavation, common, including dredging	do....	38,078
Stone for rock-face masonry, cut and delivered in yard	do....	1,592
Stone for pointed-face masonry, cut and delivered in yard	do....	1,302
Stone for cut-stone masonry, cut and delivered in yard	do....	164
Stone for sills, cut and delivered in yard	do....	213
Stone for quoins, cut and delivered in yard	do....	17
Stone for coping, cut and delivered in yard	do....	209
Stone for backing masonry, cut and delivered in yard	do....	4,129
Stone for concrete, broken and delivered in yard	do....	7,065

For a general description of Lock and Dam No. 11 as planned, including the site and foundations, reference may be made to pp. 2588 and 2589, Report of Chief of Engineers—for 1893.

OPERATING THE COMPLETED WORKS.

With the exception of Lock No. 4, which was under repairs about four weeks in April and May, and No. 2 two days, as reported below, the seven completed locks and dams remained in good working order during the year. As usual a good deal was done, mainly by the regular lockmen, in keeping the works in order. Some of the most important items of repair are mentioned below.

Fluctuations in the river during the fall and early winter made frequent lowering and raising of the movable dams necessary. The maneuvers of the dams are reported below.

Locks Nos. 2 and 3—fixed dams.—Locking was suspended at No. 2 two days in June to bulkhead the fore bay (by raising the trestle dam at head of lock) to make some slight repairs to the valve gearing. There was no suspension at either of the fixed dams during the year by high water or ice. In addition to ordinary repairs 320 cubic yards of stone (partly boated from quarry and partly from Morris Creek Bar) were used at No. 3 in repairing and strengthening riprap below the works. At No. 2 about 100 cubic yards of stone were quarried and hauled to the site for future repairs on the dam.

The commerce through Locks 2 and 3 during the year was as follows:

	Lock No. 2.	Lock No. 3.
Coal ..... bushels..	1,386,000	2,540,600
Coke ..... tons..	4,005	4,005
Miscellaneous freight, merchandise, produce, etc., by steamboats ....do....	4,326	5,245
Lumber and logs ..... feet, B. M..	102,800	416,250
Coal and coke barges ..... number..	276	532
Steamboats ..... do....	1,512	1,692
Other craft, house boats, etc ..... do....	54	63
Shingles ..... do....	193,750	401,000
Brick ..... do....	7,600	142,900
Passengers ..... do....	6,647	8,662
Lockages made ..... do....	1,596	1,828

Lock No. 4, movable dam.—This dam was kept up one hundred and eighty-five days during the year.

In addition to ordinary repairs the following important items of work were done at No. 4 during the year: The timber was purchased for a new set of lock gates and the same framed, bolted, and keyed ready to be assembled. In April the lock chamber was cofferdammed and pumped out. This is the first time the water has been out of the chamber since the work was put in operation in 1880. An examination of the gates, now fourteen years old, showed them to be in better condition than expected, and it was decided to strengthen and repair them by sheathing the downstream faces with 1½-inch plank, etc., and postpone putting in the new gates as long as practicable. New miter sill cushions were also put in throughout—the old ones being considerably worn on upstream faces. The main part of the damage to the sills was caused by the *maneuvering chains* first used on the gates, but now abandoned at all of the locks for spars and lines.

One of these miter sills lifted a little in 1889 and was then repaired by additional wedge bolts put in by divers. The examination this spring showed that some of the original wedge bolts had been badly put in, the wedges being too small for the holes and the bolts not well grouted. The movement had been mostly in the cushions, the masonry being but little disturbed. The defective bolts were replaced and others added.

So far as known this is the only miter sill on the river that has ever moved.

The repairs to the gates and sills were completed May 7, the coffers taken out on the 8th, and the dam put up on the 9th.

Thirty shunting hurters were placed on the weir in July. This was done without letting down the dam or lowering the pool by fastening the wickets to the service bridge.

The maneuvers of the dam and some of the principal items of commerce at No. 4 are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Lowered	Aug. 30	2 30	7	No difficulty.
Raised	Sept. 7	9 0	5	Do.
Lowered	Sept. 13	2 0	4	Do.
Raised	Sept. 20	10 0	5	About one hour taken to repair wickets.
Lowered	Oct. 5	5 0	6	Some trouble with tripping bar and with a tree on the weir.
Raised	Oct. 10	9 0	6	No difficulty.
Lowered	Oct. 14	3 0	7	Tripping bar failed; wickets lowered "by hand."
Raised	Nov. 11	7 30	5	No difficulty.
Lowered	Nov. 29	2 30	6	Do.
Raised	Dec. 15 and 16.	12 0	4 to 5	Waited for No. 5 pool to fill. No difficulty.
Lowered	Dec. 31	2 0	5	No difficulty.
Raised	Jan. 9 and 10	9 30	4 to 6	Do.
Lowered	Feb. 3	2 15	6	Do.
Raised	May 9	9 0	6	Do.
Lowered	May 21	2 30	5 to 6	Do.
Raised	May 30	9 0	6	Do.

	Through the lock.	Through the navigation pass.	Total.
Coal, bushels	2,705,000	4,754,000	7,459,000
Coke, tons	445	3,560	4,005
Lumber and logs, feet, B. M.	147,700	237,250	384,950
Steamboats, number	1,015	1,070	2,085
Coal barges, do	604	829	1,433
Other craft, house boats, etc., do	33	26	59
Lockages made, do			1,135

Lock No. 5, movable dam.—The dam was kept up two hundred and three days during the year and down the rest of the time, on account of high or sufficient stages of water.

The maneuvers of the dam and the commerce at No. 5 are given in the following table:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Lowered	Aug. 30	1 55	7	No difficulty.
Raised	Sept. 6 and 7	17 0	5 to 6	Some time taken to put tripping bar on the track.
Lowered	Sept. 13	1 30	5	No difficulty.
Raised	Sept. 19 and 20	21 30	5	Delayed by breaking of tripping-bar shaft.
Lowered	Oct. 5	2 5	6	No material difficulty.
Raised	Oct. 9 and 10	8 30	5 to 6	Do.
Lowered	Oct. 14	1 15	6	No difficulty.
Raised	Nov. 10 and 11	12 55	5 to 6	Righting delayed by high stage of water.
Lowered	Nov. 29	2 10	5	No material difficulty.
Raised	Dec. 15 and 16.	11 0	5 to 6	Do.
Lowered	Dec. 31	54	3 to 7	No difficulty.
Raised	Jan. 9 and 10	11 0	5 to 6	Water rather too high; no material difficulty.
Lowered	Feb. 3	1 0	3 to 6	No difficulty.
Raised	Apr. 20	9 25	6	No material difficulty.
Lowered	May 21	2 15	4 to 5	Do.
Raised	May 30	8 45	5	Do.

	Through the lock.	Through the navigation pass.	Total.
Coal, bushels	5,599,400	7,327,400	12,926,800
Coke, tons	480	3,633	4,113
Lumber and logs, feet, B. M.	1,250,250	673,100	1,923,350
Shingles, number	479,900	235,000	714,900
Brick, do	34,600	20,100	54,700
Salt, barrels	694	615	1,309
Miscellaneous freight, merchandise, produce, etc., tons	10,886	8,928	19,814
Steamboats, number	1,300	1,128	2,428
Coal barges, do	1,230	1,421	2,651
Other craft, house boats, etc., do	51	31	82
Passengers, do	18,162	8,456	26,618
Lockages made, do			1,585

Lock No. 6, movable dam.—This dam was kept up one hundred and ninety days during the year and down the rest of the time, owing to high or sufficient stages of water.

The maneuvers of the dam and the commerce through and past this lock are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Lowered	Aug. 30	2 30	5	No difficulty.
Raised	Sept. 6	10 0	4 to 5	No material difficulty.
Lowered	Sept. 13	1 0	5	No difficulty.
Raised	Sept. 19	7 40	4 to 5	Do.
Lowered	Oct. 5	1 30	5	Do.
Raised	Oct. 9	5 30	4 to 5	Do.
Lowered	Oct. 14	1 0	5	Do.
Raised	Nov. 10 and 11.	13 30	3 to 5	Delayed by fouling of chain and by sediment in pier recess.
Lowered	Nov. 29	2 5	4 to 5	No difficulty.
Raised	Dec. 16	8 0	3 to 4	Do.
Lowered	Dec. 31	1 45	4 to 6	Do.
Raised	Jan. 28	9 45	4 to 6	No material difficulty.
Lowered	Feb. 3	1 15	5	No difficulty.
Raised	Apr. 21 and 22.	12 30	3 to 5	First spring raising. Delayed by deposit on foundations, etc.
Lowered	May 20	2 30	3 to 4	No material difficulty.
Raised	May 30	8 30	4 to 5	Do.

		Through the lock.	Through the navigation pass.	Total.
Coal	bushels	4,320,000	16,336,000	20,656,000
Coke	tons	445	3,835	4,280
Lumber and logs	feet, B. M.	1,335,750	2,533,000	3,868,750
Railroad ties	number	6,004	25,000	31,004
Staves	do	300,000	125,000	425,000
Shingles	do	46,000	.....	46,000
Brick	do	177,000	568,000	745,000
Miscellaneous freight, merchandise, produce, etc	tons	9,632	25,371	35,003
Steamboats	number	1,111	1,601	2,712
Coal barges	do	1,235	2,164	3,399
Other craft, house boats, etc	do	72	53	125
Passengers	do	10,323	17,976	28,299
Lockages made	do	.....	.....	1,329

Locks Nos. 7 and 8, movable dams.—These two works, as before stated, were put in operation on October 10. Though practically completed at that date, considerable remained to be done at both works at building and fitting up shops and storerooms, building tramways from storehouses to lock walls, building fences, cleaning up grounds, etc.

The swift current along the shore below the abutment (caused by keeping part of the weir down on that side in flush stages when the dam is up) undermined the foot of the bank below the riprapping and made it necessary to extend the protection farther downstream at both of these works; at No. 7 about 400 cubic yards of stone and spalls and 8 wagonloads of brush were placed for this and 209 yards of stone piled on the top of the bank for future use. At No. 8 about 1,350 cubic yards of stone and spalls were used in this way and about 460 cubic yards of earth handled in grading the bank to prepare it for the riprap.

The work at 7 and 8 referred to under this head was done by the regular lock hands, assisted as far as necessary by hired labor. It being new work, the extra hired labor and the cost of materials were charged to the improving account.

The maneuvers of Dams 7 and 8 since the works were put in operation are given in the following tables. The commercial statistics were kept at both of these works after completion as at the other locks and dams, but, not embracing the whole year, are omitted in this report.

Lock and Dam No. 7.

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		h. m.		
Raised	Oct. 10 and 11.	16 55	6 to 8	First regular raising. Delayed by stone and gravel on foundations, etc.
Lowered	Oct. 14	3 35	5 to 9	Winch working hard. No material difficulty.
Raised	Nov. 11 and 12.	10 5	4 to 6	Delayed two hours by stones on foundations and drift.
Lowered	Nov. 29	1 30	6	No difficulty.
Raised	Dec. 20 and 21.	14 25	5 to 6	Delayed three hours by foul chains and prop out of slide.
Lowered	Dec. 31	1 10	5 to 6	No difficulty.
Raised	Jan. 28 and 29.	13 35	4 to 6	Some delay by drifts under props.
Lowered	Feb. 3	2 55	5 to 6	Delayed one hour by drift.
Raised	Apr. 24, 25, and 26.	22 30	3 to 5	First spring raising. Delayed by deposit, chains being fouled, etc.
Lowered	May 20	55	6	No difficulty.
Raised	May 29 and 30.	11 5	4 to 7	Delayed two hours by chains fouling and by drift.

Lock and Dam No. 8.

Raised	Oct. 11 and 12.	18 0	5 to 8	First regular raising. Some time spent in attaching chains, etc.
Lowered	Oct. 14	3 0	9	No material difficulty.
Raised	Nov. 11	11 15	4 to 6	Some delay from deposit on foundations.
Lowered	Nov. 29	2 45	6 to 8	No material difficulty.
Raised	Apr. 26, 27, and 28.	16 20	5	First spring raising. Delayed by deposit, props out of slides, etc.
Lowered	May 20	2 15	4 to 5	No material difficulty.
Raised	May 30	10 30	4	Delayed two hours by fouled chains, etc.

The delays noted in raising Dams 7 and 8 are mostly incident to new works, being caused mainly by stones and gravel washed on the foundations from recent dredging to remove cofferdams, etc.

MISCELLANEOUS WORK.

Dredging.—The Government dredge, assisted by the towboat *Bee*, was employed during the working season (embracing about seven months) whenever the stage of water would admit. The following is a brief summary of operations at dredging:

The work of deepening and widening the towing channel just below Lock 8 was in progress on July 1. This was continued, part of the time being spent on the gravel reefs below Plymouth, until October 6. From this until November 10 dredging in the lower approach of Lock No. 7. From November 11 to the 18th, in the lower approach and just below Lock 6. From November 20 to the 24th, tearing up and removing a sunken coal barge from channel near Peerless in the No. 5 pool. From November 24 to December 1 was spent in repairing the boiler of the dredge. On December 2 work was begun at the head of Scary Shoal in the No. 8 pool, and was continued until the 13th, when the crews were discharged and the boats laid up for winter. This spring some repairs were necessary on the boats, the most important of which was a new boiler on the *Bee*. Another Ward tubular boiler was put on, the old one, then 14 years old, having given good satisfaction.

Work at Scary in the No. 8 pool was resumed on April 30 and was continued until June 18. From June 19 to the 23d was spent in making a channel through a gravel reef below Plymouth and taking out some "lumps" missed last fall in that vicinity. The work at Scary was resumed June 25 and is still in progress.

This dredging in the pools is nearly all hard digging, stone and gravel, the latter sometimes "cemented," and occasionally clay hardpan. The cutting is light, generally from 1 to 2 feet deep, to reduce flat places near the heads of the pools to miter sill level, and a great deal of ground is worked over for the quantity of material handled. During the year about 35,000 cubic yards have been dredged, nearly all of which was removed in dump boats.

New dump boat.—The new dump boat, contracted for with Mr. Layton Williams, was completed in August.

Lock houses, etc.—The two frame houses, including an office and outbuilding, one at Lock 9 and one at No. 10, contracted for in 1893 with James M. Mays, were completed in October. During the year a small frame house, for use by the inspectors

during construction and finally by the lockkeeper, was built at No. 11 by contract with M. V. Smith.

During the year the United States bought about three-quarters of an acre more land at Lock 4 and about the same amount additional at Lock 5. There was a small frame house on each of these lots, and authority to make them suitable for lock houses by some repairs and additions was obtained. The work on these two houses, done to a considerable extent by the lock men, is now well advanced.

Steam launch.—The light-draft steam launch, described in the last annual report, was completed by the builder, Mr. Charles Ward, in July. The trial for speed was made in the No. 6 pool over a carefully measured mile July 27. Six miles were run according to the agreement, three up stream and three down, with an average result of 12.29 miles per hour. The boat has been in use since as needed for trips of inspection and to carry light supplies to the locks. The expenses for repairs on the launch have been slight and its performance has on the whole been very satisfactory.

Lock-gate anchorage.—You have recently entered into contract with the Van Dorn Iron Works Company, of Cleveland, the lowest bidder, to furnish the anchorage for the lock gates and line hooks for Locks 9, 10, and 11. The contract, so far as this office is informed, has not yet been approved by the Chief of Engineers. These irons are essentially like those used at, and referred to in former reports under, Locks 7 and 8.

Telephone line.—During the year the Government telephone line was extended from Lock 8 to sites Nos. 9, 10, and 11, a distance of 34½ miles. The line is now 93½ miles long, reaching from Kanawha Falls to the site of Lock 11, connecting with each lock and with this office, making 12 stations in all. A considerable work is required to keep the line in order. In addition to ordinary work on the older parts of the line, 226 new poles were put up during the year in making repairs. The repairs to the line above Lock 9 are mostly made by the regular lock hands.

Office work, surveys, etc.—In addition to field and office work directly connected with the supervision of and estimates on the three locks under construction, the most important items of engineering and drafting during the year were as follows: Detailed working drawings and tracings and blue prints of same for foundations and masonry of Locks and Dams Nos. 9, 10, and 11; drawings of ironwork for the locks and navigation passes of these three works; tracings of the large scale map of the river in 15 sheets; hydrographical surveys and maps of Harvey Shoal and vicinity in the No. 3 pool, and of Scary Shoal and above in the No. 8 pool, to define the dredging proposed at these two places for improvement in the towing channels; three lines of close levels from the miter sill at Lock 8 to check bench marks and gauges at the sites of Locks 9, 10, and 11.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 24, 1894.

Statement of the number of tons of coal, including that manufactured into coke, shipped by river from mines on the Great Kanawha, for the several fiscal years named.

Years.	Tons.	Years.	Tons.	Years.	Tons.
1875	161,932	1885	712,493	1891	1,030,454
1876	200,962	1886	714,465	1892	1,071,511
1877	207,346	1887	929,335	1893	919,320
1881	385,148	1888	804,025	1894	1,032,840
1883	614,818	1889	1,076,872		
1884	736,843	1890	966,462		

Tonnage of the Great Kanawha River for the year ending June 30, 1894.

Articles.	Quantity.	Tonnage.	Articles.	Quantity.	Tonnage.
Coal.....bushels..	25,821,000	1,032,840	Brick	888,000	2,220
Timber.....feet B. M..	19,648,000	32,920	Salt.....barrels..	3,180	440
Staves, oak.....	501,000	1,500	Merchandise and produce on steamboats ...	.....	64,000
Tan bark.....cords..	880	880			
Hoop poles	115,000	290			
Railroad ties, oak	580,860	87,130	Total.....	.....	1,222,530
Shingles.....	2,067,000	310			

Total tonnage:
1890 (Report of Chief of Engineers, p. 2246)..... 1,127,223
1891 (Report of Chief of Engineers, p. 2425)..... 1,225,255
1892 (Report of Chief of Engineers, p. 2062)..... 1,360,750
1893 (Report of Chief of Engineers, p. 2593)..... 1,116,537

Respectfully submitted.

ADDISON M. SCOTT,
Resident Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

G G 2.

OPERATING AND CARE OF LOCKS AND DAMS ON THE GREAT KANAWHA RIVER, WEST VIRGINIA.

During the fiscal year the expense of operating the locks and dams on the Great Kanawha River, in West Virginia, has been paid in the manner indicated by section 4, act of July 5, 1894.

In compliance with the proviso to that section, which requires the rendition of an itemized statement of such expenses, the following is submitted:

Statement of expenses during the fiscal year ending June 30, 1894, out of the general appropriation for "operating and care of canals and other works of navigation," in operating and keeping in repair the locks and dams on the Great Kanawha River, West Virginia.

Lock and Dam No. 2:		
For wages of regular lock hands	$2,162.50	
For repairs and extra labor.....	445.95	
For supplies, as paints, oils, fuel, tools, etc.....	86.45	
For freights and transportation.....	7.25	
		$2,702.15
Lock and Dam No. 3:		
For wages of regular lock hands	2,273.67	
For repairs and extra labor.....	36.38	
For supplies, as paints, oils, fuel, tools, etc	69.13	
For freights and transportation	16.50	
		2,395.68
Lock and Dam No. 4:		
For wages of regular lock hands.....	2,286.00	
For repairs and extra labor.....	4,691.83	
For supplies, as paints, oils, fuel, tools, etc.....	78.13	
For freights and transportation	10.85	
		7,066.81
Lock and Dam No. 5:		
For wages of regular lock hands	2,416.49	
For repairs and extra labor	776.95	
For supplies, as paints, oils, fuel, tools, etc	71.78	
For freights and transportation	6.50	
		3,271.72

Lock and Dam No. 6:		
For wages of regular lock hands	$2,508.87	
For repairs and extra labor	353.50	
For supplies, as paints, oils, fuel, tools, etc	147.47	
Lock and Dam No. 7:		$3,09.840
For wages of regular lock hands	1,621.48	
For repairs and extra labor	147.27	
For supplies, as paints, oils, fuel, tools, etc	151.94	
Lock and Dam No. 8:		1,920.69
For wages of regular lock hands	1,602.16	
For repairs and extra labor	235.66	
For supplies, as paints, oils, fuel, tools, etc	155.45	
Superintendence and central office expenses:		1,993.27
Wages	3,360.00	
Rent and supplies	361.81	
Freights and transportation	28.15	
		3,749.96
Dredging at locks and part of running expenses of steamboat:		
Wages	860.67	
Repairs and supplies	856.52	
Freights and transportation	2.12	
Telephone line:		1,719.31
Rent of instruments	147.60	
Repairs and supplies	523.03	
Freights and transportation	3.50	
		674.13
Miscellaneous		16.38
Gauge reports:		
Pay of gauge-keepers and reporters at Hinton and Kanawha Falls	156.12	
Repairs and supplies	69.54	
		225.66
		28,745.60

G G 3.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

There has been nothing done during the year for want of money.

There are several old dams that are still in use, in a small way, for power for grist or saw mills. They are a real obstruction to navigation and should be removed. They have all been reported to the district attorney some time ago, as the law requires.

The following are the amounts and dates of appropriations for improving Elk River, West Virginia:

June 18, 1878	$5,000
June 14, 1880	5,000
March 3, 1881	5,000
August 2, 1882	2,000
August 5, 1886	1,500
August 11, 1888	3,000
September 19, 1890	2,500
July 13, 1892	2,500
Total	26,500

Money statement.

July 1, 1893, balance unexpended	$84.70
June 30, 1894, amount expended during fiscal year	5.69
July 1, 1894, balance unexpended	79.01
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	3,000.00

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 21, 1894.

COMMERCIAL STATISTICS FOR ELK RIVER, WEST VIRGINIA.

Year.*	Saw logs and lumber.	Railroad ties, oak.	Staves, oak.	Hoop poles.	Hickory spokes.	Tan bark, oak.	Tonnage of timber products.
	Feet, B. M.					*Cords.*	*Tons.*
1883	5,200,000	100,000	898,334	.....	.....	.....	24,790
1884	5,975,000	125,000	1,122,500	.....	.....	.....	30,700
1885	5,100,000	250,000	1,433,750	.....	.....	.....	33,500
1886	15,361,000	250,000	1,845,000	.....	.....	.....	68,510
1888	15,900,000	330,000	1,210,000	.....	.....	.....	71,150
1889	15,750,000	295,000	1,600,000	500,000	350,000	.....	70,200
1890	26,650,000	330,000	1,380,000	150,000	568,000	300	89,880
1891	27,995,000	412,500	800,000	125,000	200,000	500	103,700
1892	44,400,000	380,000	1,405,000	.....	.....	240	139,800
1893	37,516,000	353,000	1,390,000	.....	.....	612	125,400
1894	21,844,000	302,000	900,000	.....	.....	800	92,630

* All for fiscal year ending June 30.

Of saw logs and lumber during the last year about 16,000,000 feet were poplar, 3,700,000 oak, the remainder being hemlock, ash, walnut, maple, beech, and hard pine.

The general merchandise and produce carried on the river in push boats and canoes is estimated at 4,000 tons, making the total for the year, with the timber products as above, 96,630 tons.

The falling off in the timber traffic and tonnage generally in 1894 was mainly caused by the general business depression prevailing in the whole country during the year.

Respectfully submitted.

ADDISON M. SCOTT,
Resident Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

GG 4.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

Nothing has been done this year for want of money.

The following are the amounts and dates of appropriations for improving Gauley River, West Virginia:

August 11, 1888	$3,000
September 19, 1890	3,000
July 13, 1892	3,000
Total	9,000

Money statement.

July 1, 1893, balance unexpended	$117.88
June 30, 1894, amount expended during fiscal year	102.46
July 1, 1894, balance unexpended	15.42
Amount (estimated) required for completion of existing project	66,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR GAULEY RIVER, WEST VIRGINIA.

Year ending June 30—	Saw logs.	Lumber.	Staves.	Coal.	Shingles.	Tonnage of timber.	Produce, etc.	Total from Gauley.	Merchandise to Gauley.
	Feet.	*Feet.*		*Tons.*			*Tons.*	*Tons.*	*Tons.*
1888	691,800	2,535,300	177,400	.....	.....	7,121	36	7,151	750
1889	890,400	3,615,000	274,200	.....	.....	9,491	78	9,569	1,322
1890	384,800	4,452,500	.....	.....	.....	9,676	90	9,766	1,985
1891	384,700	4,701,300	100,000	.....	.....	10,347	89	10,436	1,964
1892	261,170	5,249,200	1,200,000	.....	111,000	9,527	103	9,630	3,083
1893	302,000	5,470,000	113,700	.....	75,000	9,457	114	9,571	2,405
1894	523,000	4,765,000	483,000	525	.....	8,506	213	9,244	2,398

G G 5.

IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

There has been no work on this river in the year ending June 30, 1894.

The following are the amounts and dates of appropriations for improving New River, Virginia and West Virginia:

August 14, 1876	$15,000
June 18, 1878	15,000
March 3, 1879	12,000
June 14, 1880	24,000
March 3, 1881	24,000
August 2, 1882	12,000
August 5, 1886	10,000
Total	112,000

Money statement.

July 1, 1893, balance unexpended	2,341.79
July 1, 1894, balance unexpended	2,341.79

APPENDIX H H.

IMPROVEMENT OF CERTAIN RIVERS IN KENTUCKY AND WEST VIRGINIA.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tradewater River, Kentucky.
2. Lock No. 2, Green River, at Rumsey, Ky.
3. Green River above mouth of Big Barren River, Kentucky.
4. Operating and care of locks and dams on Green and Barren rivers, Kentucky.
5. Rough River, Kentucky.
6. Kentucky River, Kentucky.
7. Operating and care of locks and dams on Kentucky River, Kentucky.
8. Licking River between Farmers and West Liberty, Ky.
9. Big Sandy River, West Virginia and Kentucky.
10. Levisa Fork of Big Sandy River, Kentucky.
11. Tug Fork of Big Sandy River, West Virginia and Kentucky.
12. Guyandotte River, West Virginia.
13. Little Kanawha River, West Virginia.
14. Operating and care of lock and dam on Little Kanawha River, West Virginia.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 7, 1894.

GENERAL: I have the honor to transmit herewith annual reports on work under my charge at the close of the fiscal year ending June 30, 1894.

First Lieut. H. E. Waterman, Corps of Engineers, and First Lieut. James J. Meyler, Corps of Engineers, have been on duty under the direction of this office throughout the year.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

H H 1.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

The Tradewater is a tributary of the Ohio, and empties into it 79 miles below Evansville, Ind.

The project for the improvement, adopted in 1881, contemplated originally the removal of obstructions, such as bars, snags, etc., so as

to open up to navigation 22 miles of the river, by forming a channel with a minimum width of 40 feet and a minimum depth of 2½ feet for six months in each year. The survey upon which the project was based covered 41 miles of the river, and the scope of the work has been extended to embrace this, although the depth of 2½ feet can only be secured for about five months each year in the upper portion.

The river has been thoroughly gone over from its mouth to the upper limit of the improvement, 41½ miles above, and while the improvement is not permanent, the obstructions to navigation, such as snags, sunken logs, etc., being liable to re-form after each high water, no further appropriation at the present time is deemed requisite, as the unexpended balance from former appropriations will be sufficient for the ensuing fiscal year.

No work was done during the past fiscal year beyond caring for property.

APPROPRIATIONS.

March 3, 1881	$3,000
August 2, 1882	3,500
July 5, 1884	2,000
August 5, 1886	2,000
August 11, 1888	6,000
Total	16,500

Money statement.

July 1, 1893, balance unexpended	$761.35
July 1, 1894, balance unexpended	761.35
July 1, 1894, outstanding liabilities	24.00
July 1, 1894, balance available	737.35

NOTE.—It has been impossible to obtain any commercial statistics.

H H 2.

RECONSTRUCTION OF LOCK NO. 2, GREEN RIVER, AT RUMSEY KENTUCKY.

REBUILDING LOCK NO. 2.

In the deficiency act of March 3, 1893, an appropriation of $65,000 was made for rebuilding Lock No. 2, Green River. A project and estimate for the expenditure of this amount was submitted under date of March 23, 1893, and approved April 12, 1893.

The original estimate of cost of this work was $170,000, and in view of the fact that the old lock was in a dangerous condition it was deemed advisable to commence the construction of the upper end of the new lock, and then, by filling in between the land wall of the new lock and the river wall of the old lock, to secure the latter, and in this way be able to continue the use of the old lock for navigation. The plan was to build an auxiliary dam in the pool above the lock, connected by an arm at one end with the head of the old lock, and at the other end by another arm with the dam. Then, to tear out the section of old dam

between the arms of the new dam and construct the cofferdam for the new lock entirely in the lower pool. The money available, it was estimated, would build the head of the new lock complete to a short distance below the hollow quoins on top of the walls, stepping down to points on the footing courses 88 feet from the upper end of each wall, rebuild the dam to connect with river wall of new lock, and fill in between the land wall of the new lock and the river wall of the old lock. The new lock is located alongside the old one, on the water side. The contract for furnishing the necessary stone for lock walls was entered into May 18, 1893. Messrs. Eigenmann & Hollerbach, of Evansville, Ind., being the contractors. They were required to complete the delivery of stone by September 30, 1893. The time of completion of delivery was afterwards extended to November 1, 1893.

The contractors were behind almost from the first in the delivery of backing, and finally the delivery became so slow and irregular that the work of laying up the walls was stopped quite half the time. The season was far advanced and the work was liable to be closed at any time by cold weather, and everything indicating that contractors could not or would not deliver backing in reasonable quantities, they were notified that as their contract had expired no more stone would be received. It was necessary, in order to raise the new work high enough so that the filling between it and the old lock would be of any use in sustaining the latter, to use considerable quarry-faced stone in place of backing. But for the failure of the contractors, the work planned for last season would have been completed.

For details of the work done attention is invited to the report of Lieut. James J. Meyler herewith.

Abstract of contracts for rebuilding Lock No. 2, Green River, Kentucky, in force during the fiscal year ending June 30, 1894.

Contractors.	Nature of contract.	Date.	To expire.
Eigenmann & Hollerbach*	Furnishing stone	May 18, 1893	Sept. 30, 1893
J. B. Speed & Co	Furnishing cement	May 23, 1893	Do.

* Extended to November 1, 1893.

APPROPRIATION.

March 3, 1893 ..... $65,000

Money statement.

July 1, 1893, balance unexpended	$63,354.61
June 30, 1894, amount expended during fiscal year	34,295.14
July 1, 1894, balance unexpended	29,059.47
Amount (estimated) required for completion of existing project	105,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	105,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF LIEUT. JAMES J. MEYLER, CORPS OF ENGINEERS.

BOWLING GREEN, KY., *June 30, 1894.*

MAJOR: I have the honor to submit the following report of operations on Green River, Kentucky, in rebuilding Lock No. 2, for the fiscal year ending June 30, 1894:

The beginning of the fiscal year found this work in a preliminary stage. A good

force of men was engaged in constructing and erecting derricks, in building 325 linear feet of tramway from lock wall to stone yard, and in building bridge for tramway over mill race. Seven anchorages, for guys of five derricks, were constructed; built cement shed, sand bin, and coal bin; made crib for pumping engine and pumps; built sheds over pumping and hoisting engines; tore away and removed old crib (14 by 7 by 21 feet) outside of lock wall below dam, and tore away and removed 2,500 linear feet of old crib timber from site of breakwater, and dredged and removed 2,430 cubic yards of material from same place.

Construction of breakwater.—On July 10 the work of hewing timber for outer face of breakwater was started, and, three days later, the first course was framed and floated into position. This work was pushed vigorously, but the breakwater was not completed until August 14, due to considerable delay in delivery of riprap stone by the contractors. Length of breakwater, 317 feet; height, 24 feet; width, 20 feet. There was used in its construction, 22,640 linear feet of crib timber, 23,516 feet, B. M., of 3-inch sheathing, 4,664 feet, B. M., three-fourths inch battens, 5,675 pounds spikes, 2,794 cubic yards rubblestone, and 600 pounds boat spikes and nails.

Cost of material, $4,968.95; cost of labor, $1,351.84; total cost, $6,320.79.

Removal of portion of dam.—This work was begun August 9, and finished August 31. The upper slope of the dam had no breast, the sheathing extending to the river bed and being in three layers corresponding to two additions to height of dam. The filling was of slaty shale and clay, and its character, and the unusual amount and soundness of the timber, increased much the difficulty of removal. The total amount of timber, stone, and earth removed was 2,540 cubic yards; cost of removal, $1,724.96.

Construction of cofferdam.—The construction of cofferdam, surrounding head of new lock, was begun August 29, the framing and sheathing finished on September 3, and the filling on September 8. The cofferdam was built of 9-inch sawed gum timber, sheathed on both inside faces with 1-inch oak, and joints covered with three-fourths inch battens. Total length of cofferdam, 396 feet; width, 10 feet; height, 7 feet. There was used in its construction 42,820 feet, B. M., of 9 by 9 inch gum, 3,531 feet, B. M., of 6 by 3 inch oak ties, 8,216 feet, B. M., of 1-inch sheathing, 3,936 feet, B. M., of three-fourths inch battens, 2,804 pounds of spikes, and 200 pounds of nails. Cost of material, $763.52; cost of labor, $1,049.95; total cost, $1,813.47.

Removal of stone.—The work of blasting and removal of stone from site for foundation was begun September 5. This stone was of a very tough, slaty character, and a blast merely opened up a small hole instead of cracking and breaking up for some distance around. Starting with these holes, the stone had to be wedged, pried, and broken up, and then wheeled away and dumped in river below the dam. The work was finished October 17. The total amount of stone removed was 3,015 cubic yards (in place); total cost, $3,787.15; cost per cubic yard, about $1.26.

Building lock.—The first stone of new lock was set October 9, and work continued on walls until December 2. This work was subject throughout to considerable and serious delays because of failure of the contractors to deliver backing stone. The contract was awarded in May, and in June an order was sent to contractors for the special and cut stone for the first five courses and for 810 cubic yards of backing. The contractors began the delivery of stone on July 20, and from the first seemed to bend their energies toward the early delivery of cut and special stone, to the neglect of the backing. At the end of October only 532 cubic yards of backing had been delivered, less than one-third of the total amount contracted for. On November 21 the contractors were notified not to deliver any more stone, as they had gone beyond the expiration of their contract; up to this time they had delivered the full amounts of cut and special stone, and about three-fourths of the amount of backing required.

The courses in walls were each 2 feet in height, and designated as "courses A, B, C," etc., from the bottom up. The bottom course (A) was built about 88 feet long, and the walls stepped off toward the top. From course G up, work was suspended on river wall, though land wall was built up to and including part of course K. There was used in the lock the following amounts of stone, viz: Special stone, 125 cubic yards; cut stone, dressed face, 239.5 cubic yards; cut stone, quarry face, 371.4 cubic yards, and backing, 1,344.7 cubic yards.

Other stonework.—Recut special, dressed, and quarry-face stone, and drilled lewis holes in special and dressed-face stone; cut stones for gate and ladder recesses, and for ends and corners of walls. Drilled holes for fastening down needle dam sill.

Miscellaneous work.—As is usual in work of this kind, there was a considerable amount of miscellaneous work, such as moving and setting up machinery, building dump-boxes, tramway cars, and pile-driver frames, repairing tools and machinery, stopping leaks, and pumping out flooded cofferdam. The sill of needle dam was constructed and bolted down, and platform made on which to lay off patterns. At

the close of work in December the plant was put in winter quarters, the derrick in lock chamber taken down, and all timber piled and made secure. Since then work has not been resumed because of lack of funds.

Mr. B. O. Lermond, assistant engineer, was in local charge of the work at this lock.

Respectfully submitted.

JAMES J. MEYLER,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

NOTE.—For commercial statistics and list of boats, see report for operating and care, etc., Green and Barren rivers, Kentucky.

H H 3.

IMPROVEMENT OF GREEN RIVER, KENTUCKY, ABOVE MOUTH OF BIG BARREN RIVER (LOCK NO. 5).

The river and harbor act of July 13, 1892, contained the following:

Improving Green River, Kentucky, above the mouth of the Big Barren River, for Lock Number five, according to report and recommendation of Major D. W. Lockwood, Corps of Engineers, United States Army, submitted August eleventh, eighteen hundred and ninety-one, fifty thousand dollars.

This work having been assigned to me by Department letter of July 14, 1892, calling for a project for expenditure of the amount appropriated under date of July 25, 1892, I had the honor to state as follows:

Before any definite project can be submitted it will be necessary to locate the site of the lock, as the old locations have been but approximate. This will be done at an early date, when plans, etc., for the lock and dam, together with plats of land required, will be submitted for approval.

A location for this lock was originally selected by Mr. Alonzo Livermore, State engineer of Kentucky, more than fifty years ago. The point selected was at Floyds Landing, 20½ miles above Lock No. 4, Green River. In 1879 an examination was made by R. H. Fitzhugh, assistant engineer, under the orders of the late Lieut. Col. William E. Merrill, Corps of Engineers, with a view to selecting a site for this lock, and he adopted the selection made by Livermore, with an alternate location just below the mouth of Bear Creek. Assistant Engineer Fitzhugh placed the lock on the right bank of the river at Floyds Landing, against a rock bluff considerably higher than the lock walls would be, and in the hollow bend of the river, so that drift, etc., would collect in the upper entrance. I am of the opinion that Mr. Livermore must have placed the lock on the point side, but here there would be no opportunity for a rock foundation, as the bed of the river is, so far as could be determined, sand and gravel to a depth of over 20 feet.

In the fall of 1892 Assistant Engineer Westerfield examined the location at Floyds Landing, and an additional site below Bear Creek, but no definite conclusion was reached, as neither site was found to be favorable.

The geological reports of the State of Kentucky locate large deposits of coal and iron on Bear Creek and Nolin River, and it has seemed to me highly desirable that, in slackwatering the main stream, these tributaries should be considered. I have, therefore, had two additional

sites examined below Bear Creek for the location of No. 5. One of these is a short distance below one of the locations previously examined by Mr. Westerfield, and the other in the straight reach just below Bear Creek.

This section of country is practically between the sandstone and limestone formations, the line of division below Bear Creek being about at the pool water line.

The bed of the river was originally eroded to a great depth, and is now filled with gravel and sand. When rock is found on either bank it usually pitches off at a steep angle, so that, in each case examined, it has been found that even by careful examinations with an iron rod driven to final stoppage nothing very definite could be determined. It has seemed to me that the safer location would be on a gravel foundation, and that the location just below Bear Creek presents more advantages than any other yet examined.

Maps of the various localities examined will be forwarded within a very short time.

APPROPRIATION.

July 13, 1892	$50,000.00

Money statement.

July 1, 1893, balance unexpended	$49,403.98
June 30, 1894, amount expended during fiscal year	1,972.28
July 1, 1894, balance unexpended	47,431.70
Amount (estimated) required for completion of existing project	130,673.20
Amount that can be profitably expended in fiscal year ending June 30, 1896	130,673.20
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

NOTE.—For commercial statistics and list of boats, see report for Operating and care, etc., Green and Barren rivers, Kentucky.

H H 4.

OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

The United States acquired possession of the locks and dams December 11, 1888, by purchase of the unexpired lease of the Green and Barren River Navigation Company, the legislature of the State of Kentucky having ceded them, with lands and appurtenances pertaining thereto, to the United States upon condition that the latter should extinguish the claim of the navigation company to take tolls and to exercise control over said rivers.

At the time of acquiring possession four of the locks were being operated, to wit, Nos. 1, 2, and 4, Green River, and No. 1, Barren River. The river wall of No. 3, Green River, was down, having fallen into the river about the first of the year. Both walls of No. 2 were, and had been for years, in a dilapidated condition, the land wall being prevented from tumbling into the pit only by reason of being anchored back to cribs filled with stone. At No. 1, Barren, the grillage upon which the walls rested had been undermined at the lower end of the land wall so that the wall was badly cracked and appeared liable to yield at any time. The dams were nearly all in bad condition, the timber of the downstream slopes being badly decayed.

The walls at No. 3, Green, and No. 1, Barren, were completed in time to reopen the river to through navigation November 10, 1890.

The dams of No. 1, Barren, and No. 2, Green, have been rebuilt entirely from the crests forward, and the latter has been straightened by taking out the break in direction that formerly existed, and which made a fore bay for logs for a small mill on the abutment side of the river. This dam now extends directly across the river from the lock. The old guide cribs at upper and lower entrances of the locks had become useless by reason of their tumbled-down condition; these have been rebuilt, and the amount of dredging required after every rise has been materially lessened. The areas immediately behind the land walls of locks have been graded and paved, the United States land sown with grass seed and fenced in.

Eight lock-keepers' dwellings have been built and two old ones put in thorough repair. During the past year a section of Dam No. 4, Green River, 140 feet in length, has been rebuilt; the lower land guide crib at Lock No. 3, Green River, has been lengthened and raised, and three spur dikes built below it to stop abrasion of bank.

At Dam No. 1, Green River, considerable trouble is always experienced after a high rise in the Ohio River, which washes out the backing above the dam. The practice has been, when the water falls and a pressure against the upstream face of the dam is developed, to throw hickory sawdust into the river just above the dam; this is washed and drawn into the crevices, etc., and effectually stops the leaks until after another rise from below. The lock entrances have all been dredged during the year, some of them several times.

The snag boat *Wm. Preston Dixon* has been docked at the canal dock in Louisville, her wheel raised, a new deck put on over the forecastle, bustles built on her after rake, and her doctor replaced by two Monitor injectors.

Lock No. 2, Green River, was closed from August 22, 1893, to December 4, 1893, by a dam built across the head of the lock, as, with the support of the old dam against the head of the river wall withdrawn, the wall was deemed unsafe. This lock is in a very shaky condition, and its sudden failure at any time would occasion no surprise.

For details of work done during the past fiscal year, attention is invited to report of First Lieut. James J. Meyler, Corps of Engineers, herewith.

Leases in force for year ending June 30, 1894.

Location.	Lessee.	Date.	To expire.
Green River:			
Lock No. 2	Livers & Welborn	Jan. 1, 1892	Jan. 1, 1912
Lock No. 2	James Cate	Jan. 1, 1892	Jan. 1, 1912
Barren River:			
Lock No. 1	William Boulton	July 1, 1878	July 1, 1898

Collections for Green and Barren rivers for year ending June 30, 1894.

Lessees.	Location.	Subject.	Amount collected.
Livers & Welborn	Lock No. 2, Green River	Land and water power	$100
James Cate	do	do	100
Bryant & Nall	do	do	150
G. D. Hemenway	Lock No. 3, Green River	do	75
William Boulton	Lock No. 1, Barren River	do	150

The leases with Bryant & Nall and G. D. Hemenway are verbal ones, made from year to year.

APPROPRIATIONS.

August 11, 1888, for purchase	$135,000

ALLOTMENTS.

January 4, 1889	$167,112.00
July 20, 1889	139,110.00
July 17, 1890	53,783.47
July 16, 1891	77,807.26
July 15, 1892	46,264.26
July 15, 1893	49,730.88
Total	533,807.87

Detailed statement of expenses incurred in preserving and maintaining navigation on the portion of the Green and Barren rivers, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1894.

Months.	Lock No. 1, Green River.				Lock No. 2, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1893.								
July	$68.00	$19.00	$28.52	$115.52	$68.00	$19.00	$28.52	$115.52
August	230.00	35.50	10.23	275.73	230.00	6.62	10.23	246.85
September	177.50	60.70	19.19	257.39	167.00	712.74	18.59	898.33
October	182.50	3.75	52.62	238.87	137.50	.....	27.25	164.75
November	240.00	103.50	24.38	367.88	195.00	6.00	24.38	225.38
December	188.00	28.40	18.00	234.40	143.00	281.94	42.00	466.94
1894.								
January	249.00	.....	10.23	259.23	243.00	48.40	10.23	301.63
February	260.00	35.50	23.67	319.17	246.67	14.10	15.50	276.27
March	210.00	47.00	38.89	295.89	210.00	39.55	38.74	288.29
April	220.00	459.04	30.30	709.34	220.00	153.19	30.00	403.19
May	220.00	1.70	15.23	236.93	220.00	34.50	7.43	261.93
June	184.00	4.10	23.47	211.57	184.00	51.00	15.97	250.97
Total	2,429.00	798.19	294.73	3,521.92	2,264.17	1,367.04	268.84	3,900.05

Months.	Lock No. 3, Green River.				Lock No. 4, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1893.								
July	$68.00	$19.00	$50.68	$137.68	$68.00	$19.00	$10.22	$97.22
August	230.00	4,538.45	10.22	4,778.67	230.00	411.48	10.22	651.70
September	177.50	2,356.58	20.84	2,554.92	177.50	1,040.68	18.60	1,236.78
October	182.50	980.49	26.78	1,189.77	182.50	1,023.85	26.78	1,233.13
November	240.00	338.30	15.00	593.30	240.00	1,657.13	31.88	1,929.01
December	188.00	663.30	18.00	869.30	188.00	1,555.36	18.00	1,761.36
1894.								
January	249.00	29.28	10.22	288.50	249.00	24.00	10.22	283.22
February	260.00	29.50	23.00	312.50	260.00	8.15	23.00	291.15
March	210.00	36.30	37.01	283.31	210.00	122.75	41.01	373.76
April	220.00	7.00	41.97	268.97	220.00	154.98	33.59	408.57
May	220.00	8.10	7.43	235.53	220.00	60.15	7.43	287.58
June	184.00	10.00	15.56	209.56	184.00	10.00	15.57	209.57
Total	2,429.00	9,016.30	276.71	11,722.01	2,429.00	6,087.53	246.52	8,763.05

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, etc.—Continued.

Months.	Lock No. 1, Barren River.				United States snag boat Wm. Preston Dixon.				
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries and labor.	Repairs.	Supplies.	Subsistence.	Total.
1893.									
July	$68.00	$19.00	$10.22	$97.22					
August	230.00		10.22	240.22	$861.50				$861.50
September	177.50		46.04	223.54	854.16	$15.00	$438.52	$282.49	1,590.17
October	182.50		26.77	209.27	834.51				834.51
November	240.00		15.00	255.00	852.33	15.00	145.22	185.30	1,197.85
December	188.00	57.30	18.00	263.30	667.74	34.43	137.71	294.20	1,134.08
1894.									
January	249.00	10.00	10.22	269.22	566.67	19.67	180.94	7.25	774.53
February	260.00	5.00	23.06	288.06	435.00	15.25	75.93	55.45	581.63
March	210.00		37.01	247.01	435.00	23.15			458.15
April	220.00	59.38	31.12	310.50	442.50	16.82			459.32
May	220.00	15.62	7.43	243.05	681.68	188.63	70.02	134.70	1,075.03
June	184.00	35.50	15.57	235.07	1,827.60				1,827.60
Total	2,429.00	201.80	250.66	2,881.46	8,458.69	327.95	1,048.34	959.39	10,794.37

Month.	United States dredge boat Lermond.			
	Salaries and labor.	Repairs.	Supplies.	Total.
1893.				
July				
August	$320.77			$320.77
September	468.36	$81.66	$22.00	572.02
October	385.00			385.00
November	448.83	14.73	48.82	512.38
December	134.50	4.99	34.65	174.14
1894.				
January	145.00		.80	145.80
February	145.00		9.20	154.20
March	145.00	336.49		481.49
April	152.69	679.62	71.28	903.59
May	170.50		27.76	198.26
June	378.50			378.50
Total	2,894.15	1,117.49	214.51	4,226.15

SUMMARY.

Green River:	
Lock No. 1	$3,521.92
Lock No. 2	3,900.05
Lock No. 3	11,722.01
Lock No. 4	8,763.05
Barren River, Lock No. 1	2,881.46
U. S. snag boat Wm. Preston Dixon	10,794.37
U. S. dredge boat Lermond	4,226.15
Grand total	45,809.01

REPORT OF LIEUT. JAS. J. MEYLER, CORPS OF ENGINEERS.

BOWLING GREEN, KY., *June 30, 1894.*

MAJOR: I have the honor to submit the following report of operations on Green and Barren rivers, Kentucky, for the fiscal year ending June 30, 1894. The work on these streams is carried on under the indefinite appropriation for operating and care of canals and other works of navigation.

WORK DONE.

LOCK AND DAM NO. 1, GREEN RIVER.

General work.—Scraped mud from behind upper and lower lock gates; stopped leaks in dam by backing same with 1,020 cubic yards of hickory-lathe sawdust.

LOCK AND DAM NO. 2, GREEN RIVER.

General work.—Repaired lock-keeper's dwelling; dredged lock pit and entrances to lock; repaired windlass for operating lower river lock gate; constructed supporting wall on river side of river wall of lock, and between it and shore wall of new lock; built cross wall 20 feet long by 10 feet wide at upper end of old lock wall, and a crib 35 feet 6 inches long by 10 feet wide 25 feet below cross wall. Both cross wall and crib were built to level of 12 feet below top of lock wall, and the intervening space filled with 555.5 cubic yards of riprap. In order to make way for this supporting wall, it was necessary to tear away 45 linear feet of the cofferdam surrounding head of new lock, removing 106 cubic yards of earth and timber. Built small cofferdam between upper gate recesses in lock to relieve pressure on upper end of river wall, and sheathed with 2-inch oak and fastened three-fourths-inch battens over joints, and backed with sawdust, weeds, and earth; removed this cofferdam at end of season's work on new lock.

LOCK AND DAM NO. 3, GREEN RIVER.

Guide cribs and spur dikes.—The bank just below the lock had been cutting away rapidly, and, in order to stop this, the guide crib below the lock was extended and a wing built into the bank. Three short spur dikes were also built to top of bank. Guide crib was built up from a height of 15 feet to a height of 34 feet, length 300 feet, mean width 13 feet; length of wing 84 feet, mean width 13 feet, height 23 feet; average length of spur dikes 95 feet, mean width 13 feet. The spur dikes were built in steps running from the water to top of bank. In building up guide crib, wing, and spur dikes 26,766 linear feet of crib timber were hoisted, laid, and spiked, and 3,354 cubic yards of riprap stone were hoisted from barge and dumped in same; hewed face to 3,156 linear feet of crib timber for outside face of guide crib and wing; dredged and removed 400 cubic yards of material in order to prepare foundations for spur dikes. This crib work for protection of bank was finished in September, and since then there has not been any further erosion, and the filling in behind the guide crib is plainly noticeable.

General work.—Scraped lock pit and dredged entrances; cleaned well which supplies water for lock-keepers' dwellings, the water having become too muddy to drink; papered one lock-keeper's dwelling; removed tools, scrap iron, etc., from old blacksmith shop; repaired log boat.

LOCK AND DAM NO. 4, GREEN RIVER.

Repairs to dam.—Repaired 140 linear feet of upper slope of dam; prepared site for cofferdam, dredging and removing 1,125 cubic yards of material and 11 crib timbers; hewed face to 3,546 linear feet of timber; built cofferdam; tore out old sheathing and part of dam proper; laid and spiked 4,548 linear feet of timber in dam, and covered the section with new sheathing, and laid comb stick on same; tore out coffer-dam.

General work.—Drew out and dressed wicket rods of lower lock gates; dredged lock pit and entrances; hoisted from barge and stacked on bank 2,542 linear feet of crib timber; built one new tool and storage house; papered one lock-keeper's dwelling.

LOCK AND DAM NO. 1, BARREN RIVER.

General work.—Dredged lock pit and entrances; placed new caps on upper lock gates.

UNITED STATES DREDGE LERMOND.

Lock No. 2, Green River.—Dredged and removed 13,650 cubic yards of material and 45 old crib timbers and saw logs from lock pit and upper and lower chutes; tore up and removed 2,500 linear feet of old crib timber from site for breakwater, and dredged and removed 2,430 cubic yards of material from same place; dredged and threw over for backing to breakwater 950 cubic yards of material from end of island.

Lock No. 3, Green River.—Dredged and removed 2,555 cubic yards of material and 8 saw logs from lock pit and upper and lower entrances; dredged and removed 400 cubic yards of material to prepare foundation for spur dikes.

Lock No. 4, Green River.—Dredged and removed 2,050 cubic yards of material and 4[illegible]ib timbers and saw logs from lower entrance to lock; dredged and removed

1,125 cubic yards of material and 11 old crib timbers in preparing site for cofferdam to inclose section of dam.

Lock No. 1, Barren River.—Dredged and removed 3,500 cubic yards of material and 40 saw logs from upper and lower entrances and from lock pit.

General work.—Dredged 54 cubic yards of gravel from channel of river near Lock No. 4, Green River, and placed same on barge for use at Lock No. 2, Green River; dredged and removed 200 cubic yards of material from channel of river near Jones Hole, 700 cubic yards of material and 15 old crib timbers from channel of river near No. 1, 1,400 cubic yards of material from bar and channel at Boat Island, 3,025 cubic yards of material from bar and channel at Robinsons Island, 2,400 cubic yards of material from bar at Cow Ford; and 1,845 cubic yards of material from bar at lower end of Underwoods Island, all in Barren River; spent about four days on Upper Green River in dredging holes to determine character of bottom in locating site for proposed Lock No. 5; repaired boom and dipper and box fenders to spud slides; calked lower deck.

UNITED STATES SNAG BOAT WM. PRESTON DIXON.

Removed 1,210 snags, weighing 2,070 tons, from channel of river, and cut on shore 36 overhanging trees, deadened on shore 130 overhanging trees; removed 1 coal-barge wreck from channel of Green River opposite Calhoun; pulled out 2 dump scows on ways for repairs; loaded on barges and towed from South Carrollton to Lock No. 2, Green River, 555.5 cubic yards of riprap stone; spent seventeen days' time on Upper Green River between Big Rudy Creek and Floyds Landing in making soundings and borings, and assisting in other work connected with locating of lock site for proposed Lock No. 5; did all necessary towing on Green and Barren rivers; put snag boat on dry dock at Louisville and made extensive repairs, occupying thirty days' time; total miles run, 4,457.

GENERAL WORK.

Repaired 2 barges, 2 derrick boats, and 2 dump scows; made 3 new spuds for dredge *Lermond;* made extensive repairs to U. S. snag boat *Wm. Preston Dixon*, putting in new rake at stern, new false transom, increasing length of hull 16 inches, made and put up 3 new rudders, put hog chains in boat, removed main deck forward and put in new deck, calked main bottom of boat, raised cylinder frames, removed doctor and put in 2 injectors, put new coat of paint on pilot house and on outside work to boiler-deck railing, put in new fantail frames, put in new deck beams under part of forecastle deck, and made certain necessary changes in machinery and connections, because of use of injectors instead of doctor.

Respectfully submitted.

JAMES J. MEYLER,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Commercial statistics of Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1894.

Articles.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Barrels, empty	55	52	1,268	650	65
Beer	1,245	222	92	61	58
Cement	168	600	83	37	304
Coal	45,904	49,000	71,431	70,060	46,488
Flour	773	1,363	1,540	1,813	1,930
Grain	1,431	1,284	2,956	3,454	2,931
Handles	227	6,144	605	286	396
Hay	319	427	1,106	439	655
Hides	19	30	233	48	61
Hoop poles	278	770	4,342	1,329	789
Iron, manufactured	98	253	186	4	26
Live stock	482	1,285	2,056	2,658	2,284
Lumber	2,866	9,000	14,505	14,548	11,197
Merchandise	8,933	16,420	13,093	9,992	18,711
Produce	501	184	384	242	193
Salt	1,014	1,104	1,376	1,331	1,012
Stone	788	14,752	10,742	4,202	22,723
Staves and heading	.....	744	7,841	9,067	9,027
Ties, railroad	16,373	21,325	40,736	24,684	63,069
Tobacco, leaf	4,723	2,164	1,858	2,164	3,385
Timber, logs, etc	819,920	500,000	283,911	465,858	3
Whisky	57	43	51	54	
Passengers	972	1,434	1,813	1,392	
Total	907,146	628,600	462,208	614,373	

List of boats plying on Green and Barren rivers, Kentucky.

Name.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Evansville	Passenger	121	30	5	194.25
H. D. Munson	do	121	22	4	149.89
J. C. Kerr	do	120	21	3.7	121.15
Mary Stewart	do	100	20.6	3.6	99.29
Ed. J. Wood	do	80	12	4	32.97
Lela	do	70	18	3	63.27
T. C. Woodward	do	65	9	4	33.50
City of Chartiers	Towboat	120.7	20.1	2.9	113.63
Eugene	do	113	20	3.5	98.31
Longfellow	do	112	19.6	4.3	92.59
D. A. Nisbet	do	105	20	3.6	64.65
I. N. Hook	do	109	19.4	3	55.95
Little Clyde	do	100	20	3.6	53.29
Stoneware	do	100	17	3	63.19
Emma Cooper	do	95	25	3.5	78.19
Troubadour	do	93.4	18	3	61.27
Little Tom Moss	do	90	22	3	56.39
John T. Carson	do	85	18.8	3	47.69
C. O	do	81.6	15.7	2.7	33.85
Little Albert	do	64.5	19.9	2.9	36.93
Eleanor*	do	60	16	2.8	14.84
Ida*	do	60	14	3	22
Isabella	Tugboat	95	22	4.8	66.24
Emma Erwin	do	79	15	4.4	41.84
Louise	do	73	16.5	3.8	49.89
Ingleside	do	81	14	4	36
Orphan Girl	do	80	15	4	39
Uncle Buck	do	67	18	4	33.34
Mattie	do	56	8.1	3.8	12.33
Wm. Preston Dixon	U. S. snag boat	124.9	32	5	200

* Also run on Upper Green River.

Report of lockages on Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1894.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total craft and flats passing.	Total number lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
Green River:											
No. 1	349	16	414	210	104	418	227	602	72	2,047	3,261
No. 2	243	122	239	173	4	238	160	413	5	1,232	1,986
No. 3	352	13	311	236	108	300	233	304	119	1,611	1,833
No. 4	355	10	297	195	58	295	196	117	57	1,215	1,321
Barren River:											
No. 1	362	3	270	174	19	264	173	22	23	945	945
Total	1,661	164	1,531	988	293	1,515	989	1,458	276	7,050	9,346

NOTE.—Navigation through the five locks was suspended for high water only, except in the case of Lock No. 2, Green River, which was closed one hundred and four days during the progress of work on the new lock, it being considered unsafe to leave it open then.

H H 5.

IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

Rough River is a tributary of Green River, emptying into it at a point 71 miles from its mouth and 8 miles above Lock No. 2, at Rumsey.

Shortly after the war a company built a timber and stone lock, with dam and abutment, about 8 miles from the mouth of the river, and

steamboats from 110 to 125 feet long ran up the river as far as Hartford, until the Green and Barren river improvements were leased to the Green and Barren River Navigation Company by the State of Kentucky. It is claimed that the excessive tolls charged by the navigation company effectually killed the commerce of Rough River, and the lock and dam were abandoned. The dam was only 90 feet long, and shortly afterwards the river cut around the abutment. Eventually the dam was torn out, so that now nothing but the ruins of the old lock remain.

The river was much obstructed at the time work on it was commenced, and being narrow and very crooked some of the bends were almost filled with snags, sunken timber, and logs, while overhanging trees on the banks constituted a still further obstruction to steamboats.

The project for this improvement was approved October 27, 1890, and provides as follows: First, to definitely locate the site of the lock proposed and purchase or have condemned the land needed about the lock and abutment. Second, clear the river of obstructions, to wit, overhanging trees on the banks, and snags, logs, and stumps in the bed of the river. The estimate for this was $300 per mile, or $9,000 for the 30 miles between the mouth of the river and Hartford.

The preliminary work of clearing out the stream is about completed. In this work over 31,000 trees on the banks have been deadened, 5,000 tree tops, etc., cut up, 5,637 snags taken out of the bed of the river, and 839 leaning trees cut down and cut up. The timber deadened was that which by falling into the river would create obstructions, and it will be necessary, before the dam is built, to cut down all trees that would be in the river when the pool is full.

The titles to land on lock and abutment sides have been obtained, the plans, etc., of lock and dam approved, and on February 23, 1893, bids were received and opened for stone to commence the construction of the lock. Owing to the small amount of money available, the condition of navigation at Lock No. 2, Green River, and to other causes, the bids received were too high and were rejected, and the work of construction left to await further appropriation.

This work can be practically completed in one working season, and it will be much more economical to defer commencing the work, at least until sufficient money has been appropriated to complete the lock, than to expend the small amounts that have been already appropriated and continue this course with small sums, as by this method of procedure the percentage of cost of preparation will be much increased.

APPROPRIATIONS.

September 19, 1890	$25,000
July 13, 1892	15,000
Total	40,000

Money statement.

July 1 1893, balance unexpended	$32,980.02
June 30, 1894, amount expended during fiscal year	470.30
July 1, 1894, balance unexpended	32,509.72
Amount (estimated) required for completion of existing project	65,556.05
Amount that can be profitably expended in fiscal year ending June 30, 1896	65,556.05

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Commercial statistics of Rough River, Kentucky, for fiscal year ending June 30, 1894.

Articles.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Logs	89,161	.....	.....	.....
Lumber	9,000	.....	.....	.....
Timber, logs, etc	.....	50,000	75,000	64,461
Total	98,000	50,000	75,000	64,461

List of boats plying on Rough River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Uncle Buck	Tugboat	67	18	4	22.2
Stoneware	Towboat	100	17	3	62.9
Lela	Passenger	70	18	3	62.7

H H 6.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The Kentucky River is a tributary of the Ohio, and empties into it at Carrollton, Ky., about midway between Cincinnati, Ohio, and Louisville, Ky.

The present project for the improvement of the river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky, and extend slack-water navigation for a draft of 6 feet, by the construction of additional locks and dams, to Beattyville, a distance of 261 miles from the mouth of the river.

In pursuance of the foregoing, Lock No. 6—15 miles above Lock No. 5, the upper lock built by the State of Kentucky—has been completed, carrying 6 feet of slack water to High bridge.

During the past year the guide cribs at No. 6 have been completed, the grading and paving in rear of lock finished, and two lock-keepers' dwellings well advanced toward completion. A new towboat, to take the place of the snag boat *Kentucky*, has been built and has been in service most of the year. The condition of affairs at Beattyville remains about the same as reported last year.

LOCK NO. 7.

The location of this lock is a short distance below High bridge. The site has been approved, and a careful survey made of the locality, with borings to rock extending across the river. There has been some difficulty in obtaining title to the land needed on the lock side of the stream owing to the exorbitant price asked by the owners of the land, and the whole matter is now in the hands of the U. S. attorney. Plans, etc., for the lock are now in course of preparation.

For details of work done during the past fiscal year attention is respectfully invited to the report of Lieut. H. E. Waterman, Corps of Engineers, appended hereto.

APPROPRIATIONS.

March 3, 1879	$100,000	July 13, 1892	$150,000
June 14, 1880	100,000		
March 3, 1881	125,000	Total	1,497,500
August 3, 1882	225,000	Received from Taber & Cogar, October, 1888	500
July 5, 1884	250,000		
August 5, 1886	187,500		1,498,000
August 11, 1888	180,000		
September 19, 1890	180,000		

Money statement.

July 1, 1893, balance unexpended	$106,397.67
June 30, 1894, amount expended during fiscal year	39,519.45
July 1, 1894, balance unexpended	66,878.22
July 1, 1894, outstanding liabilities	1,370.66
July 1, 1894, balance available	65,507.56
Amount (estimated) required for completion of existing project	1,524,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of contract for improving Kentucky River, Kentucky, in force during the fiscal year ending June 30, 1894.

Contractor.	Nature of contract.	Date.	To expire.	Remarks.
Chas. Barnes	Construction of boat..	Nov. 9, 1892	Mar. 1, 1893	Extended to Aug. 1, 1893.

NOTE.—For list of boats plying the Kentucky River, and for commercial statistics for Kentucky River, see report for operating and care of canals, etc., as applied to Kentucky River.

REPORT OF FIRST LIEUT. H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1894.

MAJOR: The past year has been employed in completing the upper and lower guide cribs, gradir · lock grounds, and constructing two new lock-keepers' dwellings at Lock No. 6, his work will probably be about finished in another month.

Surveys and examinations made at Cow Shoal, near the Cincinnati Southern Railway, High Bridge, Ky., resulted in the adoption of this site for the new Lock No. 7. No difficulty was experienced in obtaining the property needed for the abutment from the United Society of Shakers of Pleasant Hill, Ky., but the 10.232 acres needed for the lock could not be purchased at a reasonable price, and is now in the courts for condemnation.

Last summer the old snag boat *Kentucky*, which was almost entirely worn out, was replaced by the new steamer *Gen. O. M. Poe*, which has proven of great benefit to the service.

The following is a detailed statement of the work for the past year:

LOCK NO. 6.

Lower river guide crib.—This crib is 75 feet long, 18 feet wide at upper base end, 12 feet 2 inches wide at lower base end, 12 feet 6 inches wide on top at upper end, 6 feet 8 inches wide on top at lower end, and 40 feet deep. Two holes, 1¼ by 18 inches were drilled in lower end of river wall and a piece of timber 10 by 10 inches by feet bolted on to brace middle range sticks and keep the crib perpendicular.

hundred and thirty pieces of timber, 11,985 linear feet or 86,246 feet B. M., were used in the construction of the crib and 2,909 spikes, 1,274 cubic yards of riprap, for ballast, were placed in the crib. Twelve pieces of oak, 6 by 12 inches by 16 feet, and 3 pieces, 6 by 22 inches by 24 feet, were spiked on crib as decking. Three check posts, 10 by 10 inches by 8 feet, and 1 signal post, 10 by 10 inches by 12 feet, were put in place.

Upper river guide crib.—This crib is 60 feet long, 18 feet wide at lower base end, 12 feet wide at upper base end, 12 feet wide on top at lower end, 8 feet wide on top at the upper end, and is 23 feet 1 inch deep. Five holes, each 1¼ by 14 inches, were drilled in the upper end of river wall, and a piece of timber 10 by 10 inches by 12 feet was bolted on to brace the middle range sticks and keep the crib perpendicular. Four hundred and six pieces of timber, 7,737 linear feet or 55,414 feet B. M., and 1,648 spikes were used in the construction of the crib. Twenty pieces of timber, 5 by 12 inches by 20 feet, were spiked on top for decking. Three check posts, each 10 by 10 inches by 8 feet, and 1 signal-light post, 10 by 10 inches by 10 feet, were put in place. Seven hundred and nineteen cubic yards of riprap were placed in crib as ballast.

Lower land guide crib.—The greater portion of this crib was put in during the fiscal year ending June 30, 1893. The main body of the crib is 155 feet long and 10 feet wide at the top, with a return wing at lower end extending into the bank 85 feet. Four holes, 1¼ by 18 inches, were drilled in lower end of land-lock wall, and a piece of timber, 10 by 10 inches by 8 feet, bolted on to brace the middle range sticks and keep the crib perpendicular. Three hundred and sixty-eight pieces of timber, 6,180 linear feet or 45,149 feet B. M., and 1,578 spikes were used in finishing the crib. Eight check posts, each 10 by 10 inches by 8 feet, were put in place, and 34 pieces of sheeting, 6 by 12 inches by 16 feet, spiked on top for decking. Nine hundred and fifty-two cubic yards of riprap were placed in crib as ballast.

Grading and finishing grounds.—Five hundred and thirty-eight cubic yards of material were stripped and quarried, which was utilized as follows, viz, 319 cubic yards of earth for grading grounds; 95 cubic yards of ballast for guide cribs; 124 cubic yards of stone for house foundation and paving. Hauled and wheeled 5,355 cubic yards of material in grading and finishing grounds.

Steps behind land wall.—These steps lead from the center of the land wall directly up the slope to the lock-house grounds proper. They were mostly completed last year. The steps were finished by cutting and setting 7 steps, each 3 feet 10 inches by 6 feet. One hundred and twenty-four and one-half feet of curbing were cut and laid for the steps.

Stone work.—Cut and laid 485 feet of coping 1 by 6 feet on filter of cistern. Cut and laid 485 feet of curbing for walks on lock-house grounds.

Lock-keepers' dwellings.—Finished foundation for upper dwelling by cutting and laying 6 cubic yards of pitch face stone and 2 cubic yards of rubble masonry in chimney bases. Laid 9 cubic yards of rubble masonry in walls and chimney bases of lower dwelling and cut and laid 15 cubic yards of pitch face stone in walls; also built a house 15 by 16 feet and 8 feet high, of stone, for outside cellar for lower dwelling, and laid 19 cubic yards of rubble masonry, and put shingle roof on same. All the outside woodwork, roofs, chimneys, and tin work have been completed, and both houses are ready for the plasterer.

General work.—Twenty-six cubic yards of cut stone were stored in yard; 1,744 linear feet of railroad track were taken up and stored; a drain was built behind lock house next to the cliff, 346 feet long by 1½ feet deep and 1½ feet wide, with a dry wall on one side of it, containing 29 cubic yards of stone; raised and lowered 5 derricks; 680 linear feet of railroad track were put down; derrick and horse powers were painted; a cabin was built on quarter boat, and the Government property at the lock was stored and cared for.

BEATTYVILLE DAM.

No operations undertaken except care and preservation of Government property.

ROCK SHOAL QUARRY.

No operations undertaken except the care and preservation of Government property.

UNITED STATES SNAG BOAT KENTUCKY.

The United States snag boat *Kentucky* was in commission 56 days, from October 21 to December 16, assisting in making survey of the proposed site for Lock and Dam No. 7, and acted as tender for the dredge *Ward* at Cow Shoal.

UNITED STATES DREDGE WARD.

The United States dredge *Ward* was towed to the proposed site for Lock No. 7, dug a trench, 30 feet from shore, 500 feet long, down to solid rock; dredged holes in the river, on the line of the proposed dam, for rock borings; assisted in making survey of the proposed site, and making soundings to rock in the river.

UNITED STATES DREDGE WILLIE.

The United States dredge *Willie* dredged 190 cubic yards of material for foundation of lower river crib at Lock No. 6 and 70 cubic yards for the upper river crib; assisted in sinking the upper crib; repaired machinery and cared for the boat and Government property.

UNITED STATES DERRICK BOAT.

The United States derrick boat was towed to Lock No. 6 and assisted in handling timbers for the upper and lower river guide cribs, and for the lower land crib.

Respectfully submitted.

H. E. WATERMAN,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

H H 7.

OPERATING AND KEEPING IN REPAIR THE SIX LOCKS AND DAMS ON KENTUCKY RIVER, KENTUCKY.

The United States acquired possession of these locks and dams in 1880, at which date they were in a more or less crippled condition, the timber of the dams being badly decayed and the lock gates and operating machinery in such a state as to need absolute removal or extensive repairs.

Some of the dams have been entirely rebuilt, the others nearly so. Guide walls above and below the locks have been constructed, and the banks about the locks and abutments protected by timber cribbing to prevent erosion.

New lock-keepers' houses have been built, the areas in rear of land walls graded and paved, and the grounds graded, sown with grass seed, and fenced.

With the completion of Lock and Dam No. 6, slack-water navigation was extended to High Bridge, which is 121 miles above the mouth of the Kentucky.

During the past fiscal year general repairs have been made to the dams, such as replacing sheeting torn off by drift and placing backing behind the upper breasts to stop leaks, etc. Two years ago the dam at No. 1 leaked so badly that it was impossible to keep the pool up during low water; a part of the leak was about the old abutment that had been cut out in 1880, and a part through the upper breast of the dam; the trouble at the abutment was stopped, or nearly stopped, by piling in riprap, and last season the pool kept up very well. No. 5 dam also leaked badly, but this was remedied by putting in additional backing. At No. 3 it was proposed to tear out the old timber mud sill above the stone lift wall and replace it with stone. High water prevented the completion of this work last fall, but it is proposed to finish it as soon as the water gets low enough to work to advantage. It is more than probable that within a few years this will have to be done at all the old locks. The trouble with the dam at No. 6 has been remedied by extending the lower step.

For details of work done during the past year, attention is respectfully invited to the report of Lieut. H. E. Waterman, Corps of Engineers, appended hereto.

Kentucky River, Kentucky, leases for year ending June 30, 1894.

Location.	Lessee.	Dated.	Expires.
Lock No. 4	Kentucky River Mills	July 10, 1878	July 10, 1977

This lease was made by the Commonwealth of Kentucky.

Collections for Kentucky River, Kentucky, for year ending June 30, 1894.

Lessee.	Subject.	Amount collected.
Kentucky River Mills	Land and water power	$120

ALLOTMENTS.

1885	$15,000.00	1891	$28,889.07
1886	24,000.00	1892	48,826.68
1887	35,133.60	1893	40,503.62
1888	82,308.54		
1889	82,478.50	Total	429,534.61
1890	72,394.80		

Detailed statement of expenses incurred in preserving and maintaining navigation of that portion of the Kentucky River, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1894.

Months.	Lock No. 1.				Lock No. 2.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1893.								
July	$64.99	.....	$21.84	$86.83	$65.01	.....	$4.80	$69.91
August	192.50	.....	3.32	195.82	192.50	.....	3.00	195.50
September	204.16	$19.75	6.04	229.95	179.16	$237.10	4.86	421.12
October	172.50	37.00	4.08	213.58	197.50	99.89	2.40	299.79
November	234.17	140.13	6.83	381.13	234.17	.....	5.40	239.57
December	226.66	30.00	8.96	265.62	226.66	517.39	1.00	745.05
1894.								
January	187.49	83.37	13.52	284.38	212.49	266.83	2.40	481.72
February	224.17	72.24	28.83	325.24	224.17	1,112.88	19.54	1,356.59
March	206.67	.....	2.81	209.48	206.67	154.35	2.00	363.02
April	192.49	30.00	17.39	239.88	192.49	161.15	10.59	364.23
May	192.50	9.21	1.16	202.87	192.50	472.73	2.40	667.63
June	156.67	.....	.....	156.67	156.67	208.87	.....	365.54
Total	2,254.97	421.70	114.78	2,791.45	2,279.99	3,231.19	58.39	5,569.57

Months.	Lock No. 3.				Lock No. 4.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1893.								
July	$64.99	.....	$4.80	$69.79	$65.00	.....	$5.80	$70.80
August	192.50	.....	3.00	195.50	192.50	$28.50	3.00	224.00
September	179.17	$78.19	12.00	269.36	179.17	27.03	4.86	211.06
October	197.50	22.06	4.20	223.76	175.00	98.30	4.70	278.00
November	234.16	1,331.50	23.52	1,589.18	211.66	245.96	5.40	463.02
December	226.67	1,562.75	.....	1,789.42	226.67	523.04	.....	749.71
1894.								
January	212.50	607.57	6.49	826.56	212.50	217.99	2.40	432.89
February	224.16	1,130.78	26.27	1,381.21	224.16	1,107.58	11.73	1,343.47
March	206.67	158.34	1.00	366.01	206.67	313.89	1.00	521.56
April	192.50	161.16	10.59	364.25	192.50	162.66	10.60	365.76
May	192.50	522.59	2.40	717.49	192.50	517.24	2.40	712.14
June	156.66	.....	.....	156.66	156.66	31.50	.....	188.16
Total	2,279.98	5,574.94	94.27	7,949.19	2,234.99	3,273.69	51.89	5,560.57

Detailed statement of expenses incurred in preserving and maintaining navigation of that portion of the Kentucky River, Kentucky, etc.—Continued.

Months.	Lock No. 5.				Lock No. 6.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1893.								
July	$65.00	.....	$4.80	$69.80	$65.01	.....	$4.80	$69.81
August	192.50	$24.00	3.00	219.50	192.50	.....	7.60	200.10
September	204.17	25.60	9.66	239.43	164.17	$1,413.24	4.86	1,582.27
October	172.50	328.30	13.50	514.30	127.50	5,826.17	9.49	5,963.16
November	234.17	1,175.56	4.80	1,414.53	169.17	949.17	5.40	1,123.74
December	226.67	12.00	.....	238.67	176.67	.....	1.88	178.55
1894.								
January	212.51	24.37	2.40	239.28	162.51	.....	2.40	164.91
February	224.17	40.31	11.34	275.82	174.17	6.47	40.57	221.21
March	206.66	1.00	.....	207.66	156.66	24.19	1.00	181.85
April	192.51	.....	10.60	203.11	142.51	4.65	20.95	168.11
May	192.50	10.20	4.80	207.50	142.50	37.44	60.00	239.94
June	156.67	6.75	.....	163.42	106.67	.....	.....	106.67
Total	2,280.03	1,648.09	64.90	3,993.02	1,780.04	8,261.33	158.95	10,200.32

Months.	United States snag boat Kentucky.				United States steamer Gen. O. M. Poe.				
	Salaries and labor.	Repairs.	Supplies.	Total.	Salaries and labor.	Repairs.	Supplies.	Subsistence.	Total.
1893.									
July	.....	.....	.....	.....	.....	.....	.....	.....	.....
August	$937.40	.....	.....	$937.40	.....	.....	.....	.....	.....
September	315.60	.....	$22.67	338.27	$619.89	.....	.....	.....	$619.89
October	45.00	.....	.....	45.00	923.00	.....	$76.54	.....	999.54
November	115.17	.....	191.80	306.97	911.26	.....	1,095.89	.....	2,007.15
December	.....	.....	.....	.....	734.16	$82.70	63.76	.....	880.62
1894.									
January	21.00	$2.00	.....	23.00	736.55	.....	330.54	$293.37	1,360.46
February	45.00	.....	64.91	109.91	434.30	139.77	335.36	181.14	1,090.57
March	45.00	.....	.....	45.00	427.00	.83	67.87	8.51	504.21
April	45.00	.....	.....	45.00	438.33	40.31	32.02	73.47	584.13
May	15.00	.....	.....	15.00	703.65	138.78	123.03	44.25	1,009.71
June	18.00	.....	.....	18.00	718.34	136.10	111.56	85.61	1,051.61
Total	1,602.17	2.00	279.38	1,883.55	6,646.48	538.49	2,236.57	686.35	10,107.89

Months.	United States dredge Willie.				United States dredge Ward.			
	Salaries and labor.	Repairs.	Supplies.	Total.	Salaries and labor.	Repairs.	Supplies.	Total.
1893.								
July	.....	.....	.....	.....	.....	.....	.....	.....
August	$412.50	.....	.....	$412.50	.....	.....	.....	.....
September	390.00	.....	$24.54	414.54	$175.00	.....	.....	$175.00
October	466.50	.....	.....	466.50	.....	.....	.....	.....
November	339.00	.....	45.15	384.15	69.50	$40.02	.....	109.52
December	390.00	$151.79	.....	541.79	6.33	124.72	.....	131.05
1894.								
January	300.50	.....	8.80	309.30	141.33	.....	.....	141.33
February	62.00	.....	29.30	91.30	83.00	.....	$18.00	101.00
March	50.00	142.22	.....	192.22	95.00	142.23	.....	237.23
April	50.00	.....	.....	50.00	95.00	173.07	.....	268.07
May	50.00	.....	.....	50.00	135.00	.....	.....	135.00
June	95.00	.....	.....	95.00	271.00	.....	.....	271.00
Total	2,605.50	294.01	107.79	3,007.30	1,071.16	480.04	18.00	1,569.20

Detailed statement of expenses incurred in preserving and maintaining navigation of that portion of the Kentucky River, Kentucky, etc.—Continued.

Months.	United States derrick boat.		
	Salaries and labor.	Material.	Total.
1893.			
July			
August	$13.50		$13.50
September			
October			
November		$18.50	18.50
December	52.50		52.50
1894.			
January	40.00		40.00
February		7.50	7.50
March			
April			
May			
June	22.00		22.00
Total	128.00	26.00	154.00

SUMMARY.

Kentucky River:	
Lock No. 1	$2,791.45
Lock No. 2	5,569.57
Lock No. 3	7,949.19
Lock No. 4	5,569.57
Lock No. 5	3,993.02
Lock No. 6	10,206.22
United States snag boat *Kentucky*	1,883.55
United States steamer *Gen. O. M. Poe*	10,107.89
United States dredge *Willie*	3,007.30
United States dredge *Ward*	1,569.20
United States derrick boat	154.00
Grand total	52,786.06

REPORT OF FIRST LIEUT. H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., June 30, 1894.

MAJOR: I have the honor to submit the following report on the operating and care of canals, and the maintaining and preserving of navigation on the Kentucky River for the fiscal year ending June 30, 1894:

During the past year the channel span of the Louisville and Nashville Railroad bridge at Frankfort, Ky., has been raised 5.54 feet, as directed by the honorable Secretary of War. A new city and county bridge has also been built in place of the old one at Frankfort. This bridge is a single-span bridge and is nearly a foot higher than the railroad bridge. It has not yet been accepted, however, as the old bridge piers have not been removed as required. There is a clearance under all bridges on the river of at least 13.6 feet.

The work at the various locks and dams, proposed under last year's project, has not been entirely completed on account of high watar and other delays, and a considerable amount will lapse over into the coming year. One principal cause of delay in the work this year was the fact that for two-thirds of the month of August, in the heart of the working season, it was necessary for the snag boat *Kentucky* to be absent at Cincinnati, fitting out the new steamer *Gen. O. M. Poe*, and until the arrival of the latter at Carrollton, Ky., August 23, 1893, all work involving the use of a towboat was suspended.

Some trouble was experienced by leaks at Dams Nos. 2, 3, 4, and 5 last summer. The leaks at Nos. 4 and 5 were stopped by putting in new backing, and that at No. 2, which was through the slope sheeting, by patching the upper part of this sheeting. Dam No. 3 needs new slope sheeting throughout. This is on hand, and it was intended to do the work this year, but high water prevented. It will be done next month, and I think, with the possible exception of Dam No. 1, little trouble will then be experienced from leaky dams during the coming season.

The new miter sill at Lock No. 3, and the new lower gates at this lock are to be put in during the coming month. It was proposed last year to repair the old wooden sill, but it was finally concluded to replace it with stone, and this, in my opinion, will have to be done soon with all the old sills.

The bottom of the old locks, near the miter sill, is sheeted over, and this sheeting caused an immense amount of trouble in building cofferdams, as it furnishes an open route for the entrance of water under the coffer. It was tight originally, but is now rapidly wearing out, and the sills should be replaced with stone. After this is done all sheeting covering the rock bottom should be torn out.

At Dam No. 6 an apron was placed below the bottom step, and I think it has proven of great benefit. I would recommend that in future dams the lower step be made at least double that of any other, if practicable.

The following is a detailed statement of work done during the past fiscal year:

LOCK NO. 1.

Dam.—Removed 19 pieces, 1,744 feet, B. M., of defective sheeting and replaced same with new oak sheeting; respiked old sheeting on dam; placed four new pieces of timber on comb of dam.

Lock.—Painted lock gates, operating irons, and check posts; repaired upper gates by spiking poplar plank seven-eighths inch thick on each miter post; removed 5 pieces of timber, 2 logs and 1 large stone from lock pit.

Lower land crib.—Placed 2,016 feet, B. M., oak sheeting on lower land crib.

General work.—Operating and caring for lock and other Government property. Built 1,081 linear feet of board fence between lock and turnpike, and 140 feet of wire fence; removed 25 panels of old fence, excavated 55 cubic yards of earth and stone, and replaced old fence; dug ditch above slope wall from steps to sewer; dug drain in back of yard; cut and cleared brush and undergrowth from bank above slope wall and lower land crib; papered and painted lock-keepers' dwelling; repaired tool house and built partition in same to keep tools; whitewashed fences around Government property; removed drift from lock entrances and snow and ice from lock walls; scraped mud from behind lock gates; destroyed vegetation from slope walls, walks and cribs. Dredge *Willie* dredged 170 cubic yards from lower entrance. Highest water occured on February 8, the upper guage reading 18.80 feet, lower guage 31.70 feet. Lowest water occurred September 30, the upper guage reading 6.70 feet, lower gauge 5 feet.

LOCK NO. 2.

Dam.—Removed 6,216 feet, B. M., of defective sheeting from dam and replaced it with new oak sheeting; respiked the old sheeting on lower step; placed new comb-stick on dam.

Lock.—Removed broken pintle from lower river gate and placed new pintle in position; repaired wicket rod.

New lock gates.—A pair of lower lock gates for this lock was built at Lock No. 6, loaded on barge and towed to Lock No. 2. The old lock gates were removed, towed about 1,000 feet below the lock, and beached; a cofferdam was constructed in lower entrance, the water pumped from it, and the old pintles were removed and replaced with new ones; rigged the 40-foot traveler, which had been used in the construction of Lock No. 6, across the lock walls and used it in hanging the gates in position, after which the cofferdam was torn out and removed.

General work.—Operated and cared for the lock and other Government property. Painted lock gates, operating irons and check posts; spiked fender on upper guide pier; destroyed vegetation on slope wall, cribs, and piers; whitewashed fences and tool house; removed drift from upper and lower entrances and snow and ice from lock walls; scraped mud from behind lock gates. Dredge *Willie* dredged 560 cubic yards from upper entrance, 230 cubic yards from lower entrance, and 80 cubic yards from lock pit. Highest water occurred on February 7, the upper gauge reading 20.60 feet, lower gauge 32.10 feet. Lowest water occurred on September 19, the upper gauge reading 4.50 feet, lower gauge 5 feet.

LOCK NO. 3.

Dam.—Removed 21 pieces, 2,607 feet, B. M., of defective sheeting and replaced same with new oak sheeting; respiked old sheeting.

Lock.—Painted lock gates, operating irons, and check posts; repaired wicket in lower gate; built coffer-dam in upper entrance for building new stone miter sill, but was compelled to abandon the construction of the miter sill on account of high water; handled and stacked cut stone and timber for the new sill; removed coffer-dam.

New lock gates.—A pair of lower lock gates have been built for this lock at No. 6, and remain to be placed on barge, fitted, and the bolting irons placed in position and towed to No. 3.

General work.—Operated and cared for the lock and other Government property. Built and repaired fence on a portion of the Government property; painted and calked skiff; tore down and removed old tool house and built new tool house; excavated 16 cubic yards of earth from behind tool house and used same in grading in front of the house; removed drift from the lock entrances and snow and ice from the lock walls; scraped mud from behind lock gates. Dredge *Willie* dredged 335 cubic yards from lower entrance.

Highest water occurred on February 7, the upper gauge reading 16.90 feet; lower gauge 24.50 feet. Lowest water occurred on September 9, the upper gauge reading 5.50 feet; lower gauge 3.80 feet.

LOCK NO. 4.

Dam.—Removed 4 pieces, 383 feet B. M., of defective sheeting from the dam and replaced same with new oak sheeting; cut 4 cords of willow brush, boated it to dam, and placed it behind dam; placed 520 cubic yards of sand, clay, and gravel behind dam as backing.

Upper shore cribbing.—Removed 1,408 feet, B. M., sheeting and replaced same with new sheeting; placed 6 check posts in place.

New lock gates.—A pair of new lower lock gates for this lock were built at Lock No. 6, placed on barge, irons fitted, and towed to Lock No. 4; the old lock gates were removed and beached below the lock entrance; cofferdam constructed in lower entrance; pit pumped out; the old pintles removed and new pintles placed in position; the 40-foot traveler was rigged and used in hanging the new gates in place.

General work.—Operated and cared for the lock and other Government property; painted lock gates, operating irons, and check posts; destroyed vegetation on slope wall, walks, and cribbing; removed drift from lock entrances and snow and ice from lock walls; laid 300 feet, B. M., flooring in basement of lock-keeper's dwelling and repaired gutter of same; removed broken pintle in lower river gate and placed new pintle under same. Highest water occurred on February 7, the upper gauge reading 15.70 feet; lower gauge, 28.50 feet. Lowest water occurred on August 25, the upper gauge reading 3.90 feet; lower gauge, 5 feet.

LOCK NO. 5.

Dam.—Removed 6 defective pieces of sheeting and replaced same with new sheeting; placed behind dam, as backing, 1,905 cubic yards of sand, clay, and gravel; dredged at Clear Creek Bar by dredge *Willie*.

Upper land crib.—Length of crib, 180 feet; average width, 16 feet. Excavated 1,455 cubic yards of earth, spalls, and stones; tore out and removed 1,804 linear feet of timber; laid in position in crib 50,532 feet, B. M., timber, using 1,305 spikes; placed in crib 750 cubic yards of riprap as ballast; decked crib with 35 pieces (2,592 feet, B. M.) oak sheeting; drilled 6 holes 1¼ by 12 inches deep and bolted 1 piece of timber 10 by 10 inches by 24 feet to solid rock; drilled 4 holes in upper end of upper shore wall and bolted a piece of timber 10 by 12 inches by 28 feet to hold range sticks and to hold crib perpendicular; drilled 16 holes 2¼ by 11 inches deep, 3 holes 1¼ by 12 inches and 3 holes 1¼ by 18 inches deep into solid rock, and fastened ends of cross-ties and range sticks with iron pins 2 feet long; handled and rehandled 1,455 cubic yards of earth, spalls, riprap and stone; cut and rounded corners of upper shore lock wall; placed in position 4 check posts; excavated and placed behind crib 10 cubic yards of earth; watched and cared for Government property.

Upper river guide crib.—Spiked on upper river guide crib 11 pieces (792 feet, B. M.) oak timber, for fenders.

Lower shore entrance.—Blasted and removed a stone ledge in lower entrance 40 feet long, 3½ feet thick, and 2 feet wide.

Grading grounds.—Excavated 76 cubic yards of riprap, logs, and brush from above slope wall and 13 cubic yards from around well; placed 11 cubic yards of earth on grade above slope wall.

General work.—Operated and cared for lock and other Government property. Removed drift from lock entrances and snow and ice from lock walls; destroyed vegetation from slope wall, walks, and cribbing; scraped mud from behind lock gates; painted lock gates, operating irons, and check posts; raised wall of cistern 3 feet, and placed 2 cubic yards of earth around same in grading; sowed grass seed on grade above slope wall; cut and sodded around cistern; cut down and removed 3 trees on bank above upper guide crib and 1 tree on bank at lower end of lock wall; repaired assistant lock-keeper's house; whitewashed fences, tool house, and outbuildings.

Dredge *Willie* dredged 830 cubic yards of material from upper entrance, 80 cubic yards from lower entrance, and 70 cubic yards from lock pit. Highest water occurred

on February 7, the upper gauge reading 18.30 feet; lower gauge, 27.30 feet. Lowest water occurred on September 30, the upper gauge reading 5.60 feet; lower gauge, 3.90 feet.

LOCK NO. 6.

Reinforcing apron.—Three reinforcing cribs had been built to the lower step of the dam during the fiscal year ending June 30, 1893, viz:

Crib No. 1, extending 112 feet from the abutment side, 16 feet wide and about 12 feet deep.

Crib No. 2, extending 92 feet from the lock wall, 16 feet wide and about 14 feet deep.

Crib No. 3, extending from Crib No. 2 toward Crib No. 1, 112 feet long, 16 feet wide, and about 14 feet deep.

Crib No. 4 was to have been built and connected Cribs Nos. 1 and 3, but it was impossible to complete it on account of high water. After the water had gone down it was discovered that the cribs had not been properly tied to the dam proper, and that Crib No. 1 had been washed out entirely, and that the other cribs had been materially weakened. The two cribs were strengthened and tied securely to the dam; two new cribs were built from the abutment side, extending 212 feet, connecting with Crib No. 3. This crib is 14 feet wide and has an average depth of 16 feet. The sheeting put on extends over the previous lower step of the dam, making the present lower step 26 feet wide all the way across. Tore out and removed 3,226 linear feet of old crib; dredged for foundation 534 cubic yards of sand, gravel, and stone; 1,332 pieces of timber (26,336 linear feet, or 207,251 feet, B. M.) and 6,278 spikes were used in the construction of the crib; 2,276 cubic yards of riprap were placed in the crib as ballast; placed 25 cubic yards of cement in sacks and placed them in crib next to the abutment; bolted end of crib to the stone at abutment end, and built a small crib on apron below abutment; anchored crib to lower step of dam with galvanized-wire guy lines.

Lock.—Dredged 2,127 cubic yards of sand, gravel, and stone in lower entrance in widening the channel; dredged from lock pit 665 cubic yards of deposit.

Dam.—Placed above dam, as backing, 55 cubic yards of sand and gravel.

Lock gates for Locks Nos. 2, 3, and 4.—On account of convenience in building, it was decided to build the lower gates for Locks Nos. 2, 3, and 4 at Lock No. 6. A shed 28 feet by 90 feet was built of Georgia long-leaf yellow pine, and the irons for gates were purchased by circular letter. All the gates have been built and placed in position, with the exception of the gates for Lock No. 3. The gates for No. 3 are ready to be placed on a barge and their irons fitted.

General work.—Operated and cared for the lock and other Government property; conveyed timber, material, riprap, etc., from the river bank to reinforcing crib; carried fuel and pumped water to engines; boated coal from Oregon, Ky., to the lock; handled and stacked timber; built shed for storing engines, pumps, etc., 26 feet by 40 feet; built 680 linear feet of railroad track; built fence on portion of Government grounds; changed positions of derricks for handling timber and stone; sharpened tools; raised toe of lock gate, removed bonnet pins and cut two oil holes; drilled 40 holes in operating irons of lock gates and 8 holes in bonnet pins for oiling same; made and placed in position 3 check posts in upper guide crib; put 4 guard rails on lock walls; built 750 linear feet of fence; sowed grass seed on lawn; watched and cared for Government property. Dredge *Willie* dredged 534 cubic yards of sand, gravel, and stone for foundation of reinforcing crib, 2,180 cubic yards of sand and gravel at lower entrance, and 680 cubic yards from lock pit. Highest water occurred on February 7, the upper gauge reading 18.50 feet; lower gauge, 23.90 feet. Lowest water occurred on October 1, the upper gauge reading 5.90 feet; lower gauge, 4.40 feet. Pool No. 5 was drawn down as much as possible during the months of September and October to permit work on the reinforcing apron. On September 30 the lower gauge showed 2.40 feet.

UNITED STATES SNAG BOAT KENTUCKY.

The United States snag boat *Kentucky* has been engaged at the different locks and dams towing empty and loaded barges, boats, and scows, and acting as tender to dredges *Willie* and *Ward;* assisted in dredging lock entrance, and in laying reinforcing apron at Lock No. 6; repaired wicket rod at Lock No. 5; recovered 15,602 feet, B. M., of timber that had washed out of the reinforcing crib at Lock No. 6, and towed same back to the lock; assisted in running line of levels from Lock No. 4 to the Louisville and Nashville Railroad bridge and to the Frankfort City bridge to determine the height of the bridges; unshipped and repaired rudder; overhauled and repaired machinery. Ran 1,277 miles and removed 25 snags.

U. S. S. GEN. O. M. POE.

The U. S. S. *Gen. O. M. Poe* was placed in commission
been in commission 220 days and in ordinary 92 days
removed 22 snags. During the time the boat has be
attended to all the towing of timber, iron, stone, barges,
dams, etc., that has been necessary at the several locks
River; has acted as tender for the dredges *Ward* and *W*
ferent dams; repaired wicket rods at Locks Nos. 2 and 5
ings on lock gates at No. 5; placed new pintles under
and 4; assisted in building cofferdams at Nos. 2 and 4,
gates in position; removed cofferdams; assisted in runni
No. 4 to the bridges at Frankfort to determine their heigh
urements of miter sills at Locks Nos. 2, 3, and 4; built
Lock No. 4 and filled same with riprap; painted the bo
and went on the ways in the United States Canal dock, a
and repaired and strengthened hog chains; assisted in
in repairing and painting dredge *Ward* and derrick boat;
rudder of the boat.

UNITED STATES DREDGE WILLI

U. S. dredge *Willie* dredged 6,293 cubic yards of mate
Creek Shoal; towed to Lock No. 2 and dredged 870 cub
and lock pit; towed to Lock No. 3 and removed 335 c
towed to Lock No. 1 and dredged 170 cubic yards; towe
980 cubic yards; towed to Lock No. 6 and removed 680 cu
125 cubic yards from the lower entrance, and 2,055 c
approach, and 534 cubic yards for foundation of reenfor
on barges, and towed to Lock No. 3, 5 barges of clay and
dam.

UNITED STATES DREDGE WARI

The U. S, dredge *Ward* was employed a part of the y
the Big Sandy River, West Virginia and Kentucky; w
to Carrollton, Ky., on October 27, and replaced old boile
boiler; overhauled and repaired machinery. On the 1
towed to Lock No. 2 and assisted in constructing cofferda
gates; removed cofferdam; loaded timber and materials
4; assisted in unloading timber, iron rods, etc , on lock
in constructing cofferdam and hanging new lower ga
dump scows.

DERRICK BOAT.

The derrick boat was used in handling timbers for the r
6, and in handling and stacking timber, stone, and othe
locks and dams; assisted in building cofferdams at lo
removing same; assisted in hanging new lower lock g
painted boat and made necessary repairs to the machine
Respectfully submitted.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Commercial statistics of Kentucky River, Kentucky, for fisc

Articles.	1890.	1891.
	Tons.	*Tons.*
Beer		
Brick		
Coal	89,562	89,75
Cement		
Cooperage		
Cross-ties		
Grain	6,991	14,27
Flour	1,593	1,7
Hay	4,497	

Commercial statistics of Kentucky River, Kentucky, etc.—Continued.

Articles.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Iron	1,903	712	4,292	493	175
Live stock	2,350	3,065	2,506	2,071	2,288
Logs	158,903	224,844	72,749	63,197	68,866
Lumber	10,670	15,256	13,336	13,084	.....
Merchandise, miscellaneous	19,554	21,739	60,618	28,156	25,744
Salt	909	1,602	9,025	4,276	3,328
Timber	4,682	3,761	21,831	3,131	3,078
Tobacco	2,783	5,636	11,199	5,808	11,667
Whisky	4,142	4,306	4,098	3,263	3,732
Passengers	1,995	2,023	3,172	3,176	3,055
Total	310,354	389,219	431,846	330,449	250,817

List of stern-wheel boats plying on the Kentucky River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Kentucky	U. S. snag boat	136.6	30	4.6	330
Gen. O. M. Poe	U. S. towboat	127	30	5	300
Falls City	Packet	132.5	27	4.4	223.35
City of Clarksville	....do	126	26	3.6	194
John Barrett	....do	124.8	31	5.5	187.23
Rescue	....do	121	28	4	139.03
Lexington	....do	121	22	3.6	58.72
S. R. Van Metre	....do	112	18.3	3.4	98.56
Ida Smith	....do	111.6	17.9	2.6	44.14
Henrietta	....do	101.5	16.3	3.6	48.59
Isere	....do	101.3	20.4	3.7	63.97
Little Sandy	....do	94	16	3	39.34
J. F. O'Connell	....do	92.6	18.1	3.4	54.74
W. L. Norton	....do	76	12	1.6	43.60
Ghent*	....do	53	10	4	4.85
Tom Ross	....do	33	6.6	3.6	9.72
Angler*	....do	36	9	4	7.10
Al. Martin	Towboat	112	23.6	4	96.68
Alex. Montgomery	....do	112	24	4	85.55
Stoneware	....do	100	20	4	93.17
Troubadour	....do	97	18	3	61.37
Bessie Siler	....do	93	16	3	49
Andy*	....do	85	11	7	45.40
D. D. Baker	Saw boat	117	18.3	4.3	70.83
Sawyer	....do	116	18	4.2	70
Rover	....do	100	18	3.6	65
Dixie*	Pleasure boat	45	8.6	4	3.72
Maggie*	....do	21	6	4	1
Inez*	....do	21	6	3.6	1.50
Lotos-Eater*	....do	25	6	2.6	1.50

*Screw propeller.

Report of lockages on Kentucky River, Kentucky, for the fiscal year ending June 30, 1894.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing.	Total number lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1	365	.....	430	97	38	440	107	140	42	1,294	1,136
No. 2	354	11	396	72	68	396	78	136	76	1,222	1,108
No. 3	359	6	255	83	59	253	87	127	68	932	809
No. 4	359	6	240	83	151	240	86	127	157	1,084	947
No. 5	365	.....	147	70	132	147	74	1,140	140	1,850	1,255
No. 6	365	.....	115	76	176	116	69	1,135	170	1,857	1,097
Total	.....	.....	1,583	481	624	1,592	501	2,805	653	8,239	6,352

H H 8.

IMPROVEMENT OF LICKING RIVER, KENTUCKY, BETWEEN FARMERS AND WEST LIBERTY.

The project for the improvement of this river was approved by the Secretary of War under date of September 20, 1888, and provides for the removal of snags, detached rocks, and bowlders, with a view to improving low-water navigation and rafting.

During past years the stretch of river between Farmers and West Liberty, 68 miles in extent, has been improved each year that appropriations have been made, so far as the amount of money available would permit, the object being to enable light-draft boats to use the river at a lower stage than was formerly possible and to facilitate rafting. No work was done during the past fiscal year, there being no money available.

The original estimate of the cost of this improvement was $17,680, and it is recommended that the balance yet unappropriated, $5,000, be appropriated for the fiscal year ending June 30, 1895.

The river, under the present project, is not susceptible of permanent improvement for the reason that such obstructions as snags, leaning trees, stumps, etc., are liable to occur after each high water.

APPROPRIATIONS.

August 11, 1888	$3,000
September 19, 1890	3,000
Total	6,000

It has been impossible to obtain commercial statistics.

Money statement.

Amount (estimated) required for completion of existing project	$11,680.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

H H 9.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks, flows north a distance of 26 miles, and empties into the Ohio at Catlettsburg, Ky. The main river and the Tug form the boundary between Kentucky and West Virginia, and the upper Tug, for a distance of about 18 miles, forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia and flows northwest to its junction with the Levisa Fork, with a total length of 140 miles. The Levisa Fork rises in the southwestern part of Virginia, then entering Kentucky flows in a northerly direction. Its total length is about 189 miles.

The original project for improvement was adopted in 1878, and provided for the removal of obstructions from the Big Sandy and its two forks, in order to facilitate push-boat navigation and rafting.

In 1880 this project was modified with a view to securing slack-water navigation by a system of locks and dams, and the first lock and dam were located at Louisa, Ky., just below the junction of the two forks,

for the reason that the pools formed in the forks could be used for storage purposes during low water, and thus afford advantages for mining coal that no other location for a single lock could give.

The original project provided for a fixed dam, and, at the end of the season 1890, the lock, with its fittings, and the abutments, as well as about 80 feet of the dam, had been constructed.

The timber and shipping interests of the river having made objections to a fixed dam, under date of May 20, 1891, a Board of Engineer Officers was constituted "to consider and report upon the subject of the dam to be built in the Big Sandy River."

In its final report this Board recommended the substitution of a needle dam for the fixed dam, the clear height of the pool formed by it to be 13 feet above the sill of the navigable pass.

Under date of March 1, 1893, I had the honor to submit a partial report on movable dam proposed for this river, with maps showing the general features of the work. These were approved under date of March 6, 1893.

The approved plan calls for a navigable pass 130 feet long and a weir 140 feet long, separated from the pass by a pier.

The elevation of the sill of the pass is placed at the extreme low-water mark at the time the lock was built, thus placing it 9 inches above the lower miter sill of the lock.

At the close of the last fiscal year a part of the cofferdam, inclosing the site of the pass and pier, had been put in; the lock walls had been cut down 7 feet; the lift wall, carrying the upper miter sill, had been cut down so that the reference of the latter was 2 feet greater than that of the lower miter sill; and the contracts had been let for furnishing the iron for the foundation and fixed parts of dam.

Many obstacles were encountered in the foundation; in the first place, the bed rock was overlaid with from 6 to 10 feet of sand, and this was easily washed and gullied as soon as pressure was brought against it by excavating and pumping inside the cofferdam.

Then, when bed rock was reached, coal was found near the outer end of the pass and under the location of the pier, so that the base of foundation had to be lowered 10 feet, the result being that the masonry of this part instead of being 16 feet high is 26 feet high. It was also found that more sand excavation was required than was estimated for, as the change of conditions in the locality, by work already done, had caused an accumulation of sand not contemplated. In my last annual report I stated that it was more than likely that a slight change would be required in the original estimate of cost of movable dam, but that was before the trouble about foundations had been encountered, and before all the details of the structure had been worked out. Under date of October 13, 1893, a revised estimate of cost was submitted, and under date of May 3, 1894, the detailed plans, etc., were forwarded for approval. Both were approved under date of May 10, 1894. The increase in estimated cost is principally due to the increase in cost of foundations.

For details of work done during the past fiscal year, attention is invited to report of Assistant Engineer B. F. Thomas, hereto appended.

APPROPRIATIONS.

July 18, 1878	$12,000	August 5, 1886	$22,500
March 3, 1879	12,000	August 11, 1888	31,500
June 14, 1880	50,000	September 19, 1890	31,000
March 3, 1881	46,000	July 13, 1892	50,000
August 2, 1882	15,000		
July 5, 1884	40,000	Total	310,000

Money statement.

July 1, 1893, balance unexpended	$28,147.46
June 30, 1894, amount expended during fiscal year	26,997.06
July 1, 1894, balance expended	1,150.40
July 1, 1894, outstanding liabilities	156.02
July 1, 1894, balance available	994.38
Amount (estimated) required for completion of existing project	70,151.58
Amount that can be profitably expended in fiscal year ending June 30, 1896	70,151.58
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of contract for construction of Needle Dam, Big Sandy River, West Virginia and Kentucky, in force during the fiscal year ending June 30, 1894.

Contractor.	Nature of contract.	Date.	Expired.
Geo. Kinsey & Co.	Furnishing iron work	June 30, 1893	Aug. 15, 1893

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1894.

MAJOR: I have the honor to submit the following report on the work on Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1894:

I was assisted in the office work until October 15 by Mr. John M. G. Watt.

At the time of the last annual report stonecutting was in progress, and work upon the cofferdam for the construction of the pass and pier masonry of the needle dam was nearing completion. Owing to high water this work was not finished until the middle of July. A new pump had been ordered sometime before, but as it had not arrived, the 6-inch suction, which had been in use some years ago, was put in and steam taken from the large boilers in the yard, some 300 feet away, and pumping was begun on the 18th of July. Upon the arrival of a new pump, a few days later, the dredge *Ward* was moved to the end of the cofferdam and securely fastened, and connection was made with her boiler. This boiler was able to furnish barely sufficient steam to do the necessary work for some time, but the constant strain of twenty-four hours every day finally developed leaks, and it was decided to abandon it and return to the large boilers in the yard, which was done. While these boilers required very much more coal, they had the advantage of furnishing an abundance of steam. Connection was made with them by 2-inch pipes, lying on the cofferdam and incline, boxed and packed with sand.

The following is a detailed statement of the work done:

General description: The works at this point consist of—

1. A lock in the West Virginia bank 52 feet in clear width.
2. A pass for navigation 130 feet long, having a masonry foundation and closed with iron trestles and wooden needles.
3. A pier 12 feet wide separating the pass and weir.
4. A weir of masonry 140 feet long, surmounted by trestles and needles similar to those of the pass, but much shorter.
5. An abutment 18 feet in width adjoining the Kentucky shore.

As the original design was to build a stationary dam of the ordinary wooden type, having a high lift, and the new design is for a movable dam with masonry foundation, and necessarily of much less lift, it was thought advisable to lower the lock walls, and thus secure stone for the dam foundation. At the point where the dam joins the lock, it was necessary to transform the sloping wall into a vertical one, and, to do this properly, recesses have been cut in the masonry in order to secure good bond and make perfect connection between the old and new parts of the wall. Below the abutment, it is the intention to put in a crib for the protection of the adjacent bank; and the surface will be paved behind the abutment also. The work done so far is as follows:

1. The lock is completed except the upper gates; and that part of the wall adjoining the dam is finished under 5-foot water line, and the checks made for the connection the entire height.
2. The pass masonry and fixed ironwork and sill are all in.
3. The pier is completed to the 5-foot water line.
4. That part of the weir immediately adjoining the pier, stepping so as to make proper connection, is built.

Cofferdam.—Owing to high water, the cofferdam, which was begun June 1, was not completed until the middle of July. While the river was at a good stage for boating material, the site of the proposed dam was dredged so as to leave a bed of sand on the bed rock from 6 to 10 feet deep. Two thousand six hundred and twenty-eight cubic yards of broken stone, sand, earth, etc., were thus removed. Two rows of piles, reaching from the river wall of the lock out into the river 170 feet, were then driven above the site of the dam to the bed rock, or as near it as the circumstances would permit. The same arrangement was made below the dam. These piles were of 10 by 10 inch sawed oak, ranging in length from 25 to 35 feet, and were placed 12 feet from out to out with the thread of the stream and 8 feet center to center across the river. They were connected crosswise with planks spiked to their sides, and capped with 9 by 12 inch timber, and wales were fastened to them to support and guide the sheeting, which was driven in double rows and spiked to the wales and caps. Cross-ties were bolted to the pile caps, upon which the track for handling the materials was built. The box formed by the sheeting and piles was filled with clay and dredged material. The clay was taken in wheelbarrows from the top of the opposite bank of the river. After the water had fallen sufficiently, the dredge was put to work inside the walls thus made, removing the sand to bed rock, or as near to it as could be done, the material being cast onto and over the coffer. The weight of this material, as well as the removal of that inside, too close to the foot of the piling, caused one row of piles to cave in for some distance, permitting the clay filling, as well as the material thrown over by the dredge, to slide into the coffer. The portion thus damaged was cut out and not replaced, it being found that the remaining row of piles and sheeting answered every purpose. After the dredging was completed, the two coffer walls were connected at the outer end by a timber crib sunk to the sand and sheeted and filled with clay. This crib was banked on the outside with dredged material and roughly riprapped. The two side walls of the coffer were then connected with braces reaching from the inside of the piles near the top, and at the level of the ground below, to prevent further caving in. These braces were so spaced as to not interfere with work inside the coffer, and, after the masonry was well started they were entirely removed, the lower ones being cut off and fitted to the stonework. The sheeting was mostly driven with wooden hammers drawn up by men and let fall a distance of from 4 to 8 feet, and much of it did not go to bed rock. After the inside was excavated, the sand washed under, and it was necessary to drive additional sheeting to prevent the clay filling from coming into the coffer. The timber used was that which had been purchased for the stationary dam, except the sheeting, which was purchased at a local mill. Four hundred and forty linear feet of 3-inch, 2,000 feet of 2-inch, and 1,284 feet of 1-inch sheeting were driven, and 26,317 feet, B. M., of timber were used in the construction of the coffer this year.

Excavation in cofferdam.—As soon as the cofferdam was closed and the machinery set up, pumping was commenced, followed at once by the removal of the material inside. This was carried on by men with wheelbarrows, as well as with derrick and dump boxes. As the work progressed, getting deeper and deeper, it became more difficult to use wheelbarrows, the runways becoming so steep. Openings had been left as low as possible in the coffer for the purpose of wheeling out the material, but after a time even these were high above the bottom, and the work of removal became slow and expensive. The pump was run constantly day and night and did very effective work, not only in keeping the water out but also in removing a great deal of sand. After the excavation was begun it was found that the bed of sand in which the piles and sheeting were driven, ranging in depth from 6 feet at lock wall to 10 feet at the outer end of cofferdam, was washing into the inclosure, thus allowing the clay which had been placed in the side walls to settle down. This continued until the clay reached the bed rock, and it was found necessary to add 445 cubic yards more of clay and 640 cubic yards of backing to the cofferdam. This material was taken from the top of the Kentucky bank in wheelbarrows an average distance of 250 feet. The bed rock is much higher at the end of the dam next to lock, and it was necessary to blast it away in order to get sufficient depth for the anchor bolts which hold the pass sill down. Farther out in the coffer, where the rock is deeper, it was found to be very soft and shelly, and it was necessary to excavate about 10 feet deeper than had been expected in order to secure a firm foundation. This excavation was made through soft sandstone, coal, and fire clay, and was rendered more difficult by having a narorw cofferdam already

partly wrecked. Owing to this unexpected depth the pump had to be reset at a much lower level and a new discharge opening cut in the coffer, close down to low-water mark. The work in the coffer was stopped twice by high water which, while it did no damage to the coffer or machinery, left a heavy deposit of mud to be taken out after it had receded. Two thousand eight hundred and eighty cubic yards of earth, sand, etc., were removed from the coffer by men and wheelbarrows and with derrick and boxes; and 280 cubic yards of fire clay, soft rock, and coal and 60 yards of solid rock were also removed.

Stonecutting.—The cutting of stone for the pass, pier, and lock-wall change was completed this year, but about 100 pieces remain to be cut for the weir. The foundation stone needed no cutting, as stone already on hand was used for this purpose. On the other hand, the top courses and coping required a great deal of careful work, and each stone was cut in accordance with a plan. All stones were cut from those delivered for the lock and abutment, and most of those for the pass and pier were taken from those removed from the lock walls. These stones had been placed in three piles, and a great deal of handling was necessary to find suitable pieces for the best work, 1,680 yards being moved in order to get 253 yards required. The stone for pass, pier, and lock-wall change were cut on the West Virginia side, and those for the weir on the Kentucky side of the river. Four steam and one hand derricks, all made on the work, were used in the handling, cutting, and piling of the stone. The quantities cut were 150 yards special stone, 74.10 yards pitch-face stone, and 28.11 yards backing stone.

Concrete.—The greater part of the concrete stone was broken last year, mostly in the yard in West Virginia, but on account of the poor foundation rock found in the coffer the quantity of concrete needed was greatly increased, and a yard was prepared on the opposite shore for the purpose of breaking stone. The stone used is a fairly good sandstone, blasted from the approaches to the lock, and was broken by hand so as to pass through a 2-inch ring. After it had been wheeled or carried in cars to the point it was needed, it was necessary to screen it at times, the softer parts crushing to sand easily when handled often, and settling down on the floor where it had been dumped. The mixing of concrete was all done by hand, the mortar being similar to that used for masonry. About 1⅛ barrels of cement were required to the yard of concrete, and about 110 barrels were used in twenty-four hours. After thoroughly mixing the dry sand and cement on a large platform the water was added and a vigorous stirring with a dozen hoes quickly made a good mortar; then the stone was shoveled in and the whole mass was turned up with shovels until the stones were thoroughly covered with mortar. It was then placed in wheelbarrows and taken to where needed, or directly shoveled to the point, depending on relative location of platform and the work. It was deposited in layers about 8 inches thick, and rammed until the water covered the surface. Three hundred and eighteen cubic yards of stone were broken and 890.33 cubic yards of concrete were put in the work.

Masonry.—The laying of masonry was begun on July 28, but was not carried on continuously, owing to difficulty in securing a good foundation and the necessity of blasting to get depth for the anchor rods. The pass masonry was completed, the pier finished to a point above low water, and connection made with the weir. In order to get the stone from the yard to the site of the work, a double-track incline 180 feet long was built from the top of the bank, crossing the lock chute at lower end of lock, and connecting with the cofferdam. Tracks were laid from the incline into the stone piles and on the coffer, and a drum was placed at the head of the incline. When fitted with rope and brake, the loaded car descending brought the empty car to the top. An engine was also placed at the incline and used for removing stone taken from the outside lock wall to the piles in the yard, and in hauling machinery or other articles needed. One steam derrick was placed on the coffer dam for laying stone, and was moved outward as the work progressed. A hand derrick was set up for use in removing stone from the lock wall and for setting that part of the masonry immediately adjoining the lock. The cement used was Norton's Rosendale. The sand was obtained, largely, from the opposite shore, and it was necessary to screen all of it. The mortar was made of two parts sand to one part of cement, and it required about one-third of a barrel of cement to the cubic yard of masonry. Five hundred and ninety-five and twenty-eight hundredths cubic yards of stone were laid in the pass, 237.60 in the pier, 107.11 in the weir, and 6.97 in the lock-wall change—a total of 946.96 cubic yards.

Placing the iron.—The fixed ironwork for the pass and pier was all put in position; that for the weir was received, but has not yet been used. All the iron was weighed as received. In setting the anchor bolts, which hold the sill down, a pattern was cut and attached to a frame connecting with the coffer piles. This held the top of the bolts in the exact position necessary to receive the sill when the masonry should reach the proper height. These anchor bolts are 1¼ inches by 10½ feet long, and, at the bottom, have a disk 24 inches square. After the masonry was brought to its full

height holes were drilled into every piece of coping along the upper and lower faces of the dam, and drift bolts 8 feet long were set in cement, thus thoroughly binding the whole mass together. It was necessary also to cut channels in the masonry for the tie-rods holding the various stones together, and recesses for the nuts and washers. Seats for journal boxes and axle bearings were also cut, and holes drilled for fastening these irons down. The upstream journal box was fitted into the wooden sill and bolted to it. A flushing valve, with filling and discharge pipes, was set in the pier, to be used for keeping the trestle recess clean. Nine hundred and four feet of drift bolt holes were drilled and 113 drift bolts set; 31 lower journal boxes and 31 axle bearings were set, requiring 155 bolts and the drilling of 250 feet of holes; 31 anchor bolts were set; 16 long ties, 16 short ties, and 16 bent straps were fitted to the masonry and put in place; 31 upstream journal boxes were fitted into the sill and bolted with 124 bolts; 130 linear feet of strap iron was put, with rag spikes, on the upper exposed face of the sill.

Pass sill.—The pass sill is of the best grade of white oak that could be obtained in this region, and consists, in section, of two pieces, 16 by 17 inches each, lying one on the other, and rabbeted so as to lap 3 inches, forming a sill 31 inches in height. A check 4 inches in depth is cut in the stone floor to receive it, leaving it 28 inches in height on its downstream side. On its upper side the masonry leaves 5 inches exposed to receive the foot of the needles. This part of the sill is slightly sloped and sheeted with iron. The sill is let into the lock wall at one end and into the pier at the other end 1 foot, and is bolted every 4 feet to the masonry underneath and every 8 feet to the masonry upstream. Both sections are thus tied securely vertically and horizontally. In length the sill consists of one piece 20 feet long, one 14 feet, one 32 feet, one 34 feet, and six 30 feet; a total of 280 feet, fitted so as to break joints, and halved together at ends, lapping 2 feet. The joints are all made at anchor bolts. The timber for the sill was purchased by contract, hewn and sawed, and was counter hewn, dressed, and framed on the work.

Dredging.—The dredge *Ward* was employed only a part of the season; twenty days in July in cutting away the dump outside the lock, and thirty-seven days in furnishing steam for pumping and laying stone. It was also used for pulling out piles and sheeting from the old lock coffer and from the stationery dam, which had been driven a few years ago. The boiler, which was quite old, and had been leaking at times for some years, became very leaky while furnishing steam for the pump, being pushed full time day and night to its utmost capacity, and it was thought advisable to abandon it. It was accordingly taken off the dredge, and a couple of small boilers, not otherwise in use at the time, were substituted for it. These, however, did not prove satisfactory, and a new boiler was put on at Cincinnati after the dredge left here. A new dipper handle was made and put in, and some new gear wheels were added, and other necessary repairs made while the dredge was idle. In the twenty days the dredge worked this year 5,878 cubic yards of earth and rock were removed. The dredge remained at this point until the 16th of October, when a towboat started with it to the Kentucky River.

Removing old abutment.—The location of the movable dam is at the lower end of the lock, while that of the stationary dam was at the upper end. The abutment for that dam had been built before a change of plan was decided upon. It is proposed to use the stone in the abutment for the construction of the weir and the new abutment, and, with that in view, the ground about the old one was leveled off and a hand derrick set up and the stone partly removed. Seven hundred and sixty-three and forty-seven hundredths cubic yards were taken out and piled, and 750 yards of earth and rock were removed from behind the wall. The cement was cleaned off and the stone taken out, and it is yet expected to get from these stones the 100 pieces to cut for the weir and abutment. The lower courses were not disturbed, but will be removed as needed in the work.

General work.—The property has been cared for throughout the year. Repairs were made to the 3 barges and to the engines and tools. Five derricks and 3 dump boxes were constructed. The hoisting and pumping engines were taken from yard to coffer and set up, and returned to yard at the close of the season. The derricks and pile-drivers used in the coffer were also removed to the yard, as were also the pumps and small boilers. A large shed for cement was built, and also a blacksmith shop, engine sheds, tool shed, and boiler and engine house on barge. Three hundred feet of wagon road were built for hauling coal and cement to the river, and a pier was built from which to load the coal on boats when it was taken to the dredge. Four hundred and sixty feet of track were laid into the stone and concrete piles, in order to remove those materials. Eight hundred and five feet of runway for wheelbarrows were put in, for use in transporting sand, concrete, stone, etc., to points where needed. A temporary dam was built across the lock chute, so as to force all the water to pass the outer end of coffer and keep that chute cut out, so that the dredge, which was lying there, would not get aground. After the season's work had been closed the cofferdam and the bank of earth and rock surrounding it were

cut down to the 8-foot water line, so as to form less obstruction to navigation during rafting tides. For this purpose 441 cubic yards of loose rock and 480 cubic yards of earth were removed and 68 piles cut off. These quantities include the cutting down of the dump lying outside of and below the lock.

Summary of work done.—The following statement shows quantities of materials used and work performed:

Stone cut, special, pitch-face and backing	cubic yards..	252.21
Masonry laid, lock, pass, pier, and weir	do....	946.96
Concrete put in, pass, pier, and weir	do....	890.33
Excavation by dredge, earth, and rock	do....	5,878
Excavation by men, earth	do....	3,755
Excavation, loose rock, coal, fire clay, etc	do....	280
Excavation, solid rock	do....	60
Excavation, clay for cofferdam filling	do....	1,085
Sheet piles driven in cofferdam	linear feet..	3,794
Lumber put in coffer and elsewhere	feet, B. M..	50,279
Cement used	barrels..	1,990
Iron put in, all fixed iron of pass and pier	pounds..	40,646
Stone removed from old abutment	cubic yards..	763.47
Coal used for dredge and yard boilers	tons..	269
Oil used for lighting works	gallons..	452
Oil used for lubrication	do....	131
Nails and spikes	pounds..	2,700

There yet remains to be done the following work:

1. Completion of stone cutting for weir, 100 cubic yards.
2. Construction of weir cofferdam.
3. Putting in concrete foundation for weir, 1,100 cubic yards.
4. Laying weir, pier and abutment masonry, 1,900 cubic yards.
5. Excavating site of weir and dump outside of lock, 25,000 cubic yards.
6. Placing fixed iron on weir and trestles on pass and weir.
7. Making needles for dam and boat for caring for same.
8. Paving behind lock and abutment, 2,200 square yards.
9. Building protection crib below abutment.
10. Putting in new upper gates of lock.
11. Building two lock-tenders' dwellings.

The above work can be completed within five months after sufficient money becomes available. In addition to this, there is considerable miscellaneous work, such as grading and cleaning the grounds, smoothing off the ledge of rock in the approaches to lock, etc., which can be done, if necessary, after the lock is open to navigation.

Respectfully submitted.

B. F. THOMAS.
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Commercial statistics for fiscal year ending June 30, 1894, Big Sandy River, West Virginia and Kentucky.

Articles.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Hides	75	50	40	95	.....
Leather	34	30	4	6	.....
Lumber	3,000	3,000	60	650	400
Produce	2,511	3,000	250	1,755	2,000
Live stock	495	500	150	1,190	800
Spokes	750	2,200	4,080	530	100
Staves	7,000	1,050	5,260	1,803	1,500
Tan bark	9,831	10,000	28,950	1,950	1,000
Timber, logs and knots	208,491	225,000	300,050	331,570	200,000
Ties, railroad	15,000	10,000	99,625	68,750	40,000
Wheat	510	480	.....	.....	.....
Wool	11	15	7	7	.....
Miscellaneous	19,000	21,000	16,050	55,914	50,000
Passengers	1,874	900	1,400	2,503	1,500
Total	268,583	277,903	455,926	466,723	297,000

List of boats plying on Big Sandy River, West Virginia and Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Andy Hatcher	Stern-wheel	117	18	3	65
Beulah Brown	Side-wheel	118	15	2.5	37.71
C. C. Martin *	Stern-wheel	103	18.2	2.9	76.78
Fairplay	Side-wheel	125	19	3	49
Favorite	do	103	14.8	2.5	43.64
Frank Preston	Stern-wheel	110	18	3	60
J. C. Hopkins	Side-wheel	102.5	16.4	2.4	67
Jennie George	do	93	14	2.5	19.05
Lexington	Stern-wheel	120	22	3.5	48.72
Mary L. Hatcher	do	110.4	20	3	55.05
Sandy Valley	Side-wheel	105	14	2.8	40
Sip Bayes	do	100	14	1.8	24.12
Stella (tow) *	Stern-wheel	90	16	2	25
Virgie Ratcliff *	Side-wheel	110	15	2.6	43
Buckeye Boy (tow)	Stern-wheel				
Gate City (tow)	do				
Sea Lion (tow)	do				
Tom Spurlock (tow)	do	117	22	3	100

* New line.

REPORT RESPECTING THE NEEDLE DAM ON THE BIG SANDY RIVER NEAR LOUISA, KY.

[Printed in House Ex. Doc. No. 78, Fifty-third Congress, second session.]

WAR DEPARTMENT,
Washington, D. C., January 18, 1894.

SIR: Responding to the resolution of the House of Representatives, dated January 17, 1894, I have the honor to transmit herewith a letter from the Chief of Engineers, dated the 18th instant, submitting a copy of a letter dated October 13, 1893, from Maj. D. W. Lockwood, Corps of Engineers, containing an estimate amounting to $70,151.58 for completing the needle dam on the Big Sandy River near Louisa, Ky.

Very respectfully,

DANIEL S. LAMONT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1894.

SIR: I have the honor to acknowledge receipt of resolution of January 17, 1894, requesting the Secretary of War to furnish the House of Representatives at the earliest day possible information as to the amount necessary to complete the improvement on the Big Sandy River at Louisa, Ky., and in reply to its reference to this office for report, to submit the accompanying copy of letter of October 13, 1893, from Maj. D. W. Lockwood, Corps of Engineers, containing an estimate amounting to $70,151.58 for completing the needle dam on the Big Sandy River near Louisa.

The resolution of the House of Representatives is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, October 13, 1893.

GENERAL: Under date of March 1, 1893, I had the honor to submit a partial report on the needle dam proposed for the Big Sandy River, near Louisa, Ky., together with maps showing general features of the work.

In the "report of board of officers of the Corps of Engineers on dam in Big Sandy River, near Louisa, Ky.," dated November 10, 1891, an estimate of the cost of the structure was given. This estimate was only approximate, as at that date only the general features of the project had been considered; no details upon which a careful estimate of cost could be based had been worked out, and the character of the river bottom, beyond the fact that rock had been found at certain depths, was unknown.

The masonry of the pass is completed, and its cost has materially exceeded the original estimate, owing to the fact that coal was found in the river bottom, necessitating increased excavation for the foundation and additional masonry. It would hardly be safe to assume a different condition of affairs for the foundation of the weir. It has also been demonstrated, by the results of the past season's work, that a considerable increase in the amount of dredging over that anticipated at the time the first estimate was made will be required.

I have, therefore, the honor to submit herewith an estimate of cost of completing the work, based upon the cost of work already done and the most reliable data available at this date.

It must be borne in mind that in work of this character a considerable allowance must necessarily be made for delay and damage by high water, as each time a coffered space is flooded in the Big Sandy River a large deposit of sand is made. Besides, under the workings of the eight-hour system, the cost of labor is increased fully 20 per cent.

Estimate for completing needle dam on Big Sandy River near Louisa, Ky.

Stone cutting, 200 cubic yards, at $7	$1,400.00
Stone laying, 2,300 cubic yards, at $3.50	8,050.00
Concrete, 1,100 cubic yards, at $7	7,700.00
Excavation, 20,000 cubic yards, at 25 cents	5,000.00
Excavation, 10,000 cubic yards, at 50 cents	5,000.00
Cofferdam for weir	6,500.00
Iron, movable parts, pass, 68,428 pounds, at 12 cents	8,211.36
Iron, movable parts, weir, 44,611 pounds, at 12 cents	5,353.32
Iron, false trestles, 7,246 pounds, at 15 cents	1,086.90
500 needles, 5″ x 5″ x 16′, pass, at $2.50	1,250.00
500 needles, 3½″ x 5″ x 10′, weir, at $2	1,000.00
Boat for storing needles, etc	1,000.00
Machinery for operating dam	300.00
Paving behind lock and abutment, 2,200 square yards, at $1.50	3,300.00
Protection crib below abutment	3,000.00
New upper gates, lock	3,000.00
Two lock-keepers' dwellings	3,000.00
Engineering, superintendence, tools, etc	6,000.00
Total	70,151.58

Should the above amount be appropriated, the work can be completed in one season, and a marked saving in ultimate cost realized.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Gen. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., October 18, 1893.

Respectfully forwarded to the office of the Chief of Engineers, approved.

O. M. POE,
Colonel Corps of Engineers, etc.,
Division Engineer, Northwest Division.

H H 10.

IMPROVEMENT OF LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

The Levisa is the western of the two forks that unite at Louisa to form the Big Sandy River. It rises in the southwestern part of Virginia, at an elevation of about 1,500 feet above tide water, and flows in a northerly direction. Its banks in many cases are rocky, in others composed of sand and clay. It possesses all the characteristics of a mountain stream, a steep average slope, and pools of varying depth, separated by rock, bar, or ripples, that at low water often have but a few inches of water over them. The average fall from Pikeville to Louisa is 1.49 feet per mile, the distance being 86½ miles.

The object of the improvement has been to facilitate rafting and push-boat navigation in the upper river, and to improve low-water steamboat navigation so far as this can be done. Steamboats can not run in this or Tug Fork at dead low water, but the work done so far has been of such character as to permit of their running on smaller rises than was the case before the improvement was commenced. Push-boat navigation during low water is a very important matter on this stream, owing to the fact that there are no good roads for hauling freight, and a few inches increase in depth is a matter of no small moment to freighters. Coal mines have been opened at and near Peach Orchard, and quite extensive shipments are made by rail to Ashland, on the Ohio, where it is put in barges for transportation down that river. Could coal be shipped by water from the mines, the output of coal would be largely increased.

The work of previous years has removed the most important obstructions, so that during the past season it was only necessary to clear out chutes that had become obstructed by material washed in during the preceding high water, and take out such obstructions as logs, stumps, and snags that are always found in the channel after a rise.

The stream under the present project is incapable of permanent improvement, as the obstructions to navigation, such as snags, stumps, logs, etc., are liable to re-form at any time, and an annual appropriation of about $2,500 is needed to keep it clear.

For details of work done during the past year, attention is respectfully invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

APPROPRIATIONS.

June 14, 1880	$2,500
March 3, 1881	2,000
August 2, 1882	5,000
July 5, 1885	5,000
August 5, 1886	3,750
September 19, 1890	2,500
July 13, 1892	2,500
Total	23,250

Money statement.

July 1, 1893, balance unexpended	$873.90
June 30, 1894, amount expended during fiscal year	809.82
July 1, 1894, balance unexpended	64.08
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	2,509.00

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1894.*

MAJOR: I have the honor to report upon the improvement of the Levisa Fork of Big Sandy River for the fiscal year ending June 30, 1894.

The crew was placed in charge of Mr. Fred. McHenry, and consisted of 14 men, living upon a quarter boat and having another boat for carrying tools and explosives.

At the time of my last report the party had been out about three weeks, and it completed its work for the season on July 28—the amount of money on hand being small—removing obstructions to navigation at Jack Harris, John Lee Hatchers, Grimes Shoal, Lem Layne Shoal, Davidson Shoal, Ball Alley Rock, Prestonburg, Moody George Shoal, Wireman Shoal, Hager Shoal, Joe Auxiers, John Porter Shoal, Bird Preston Shoal, Devils Drawbars, Hells Gate Shoal, Buffalo Shoal, Vina Preston Shoal, Greasy Shoal, Wild Goose Shoal, Little White House Shoal, Jack Fannons, John Borders, Dave Kises, D. W. Garreds, William Careys, Joe. McClures, Harry McClures, Dock Millers, A. Capertons, Lick Creek, and Louisa. One hundred and fifty-ninesnags, 71 trees, 95 stumps, 120 cubic yards of solid rock, and 1,440 cubic yards of loose rock were removed, and 23 trees were topped. The river was left in very nice condition, and I think the biennial appropriation of $2,500, if continued, will maintain it in satisfactory navigable shape. There has been a marked improvement in the length of the navigable season, as well as in the carrying capacity of the boats on this stream within the last few years, and these improvements are wholly due to the work done by the Government.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

NOTE.—Commercial statistics included in the report for improving Big Sandy River, West Virginia and Kentucky.

H H 11.

IMPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Tug Fork is the eastern of the two forks which unite at the town of Louisa, 26 miles from the Ohio, to form the Big Sandy River. It rises in the southwest corner of West Virginia and flows toward the northwest for a distant of 140 miles. For a distance of 18 miles at its head it forms a part of the boundary between Virginia and West Virginia, and below this it and the Big Sandy form the boundary between West Virginia and Kentucky.

The Tug throughout most of its length is a characteristic mountain stream formed of a series of pools separated by ripples.

The average fall per mile from Pond to Warfield, a distance of 23.5 miles, is 1.96 feet per mile, and from Warfield to Louisa, a distance of 35 miles, 1.72 feet per mile.

The object of the improvement has been to facilitate rafting of logs from the upper portion of the stream and its branches, to provide a low-water push-boat channel, and to make it possible for light-draft steamboats to run at lower stages than formerly while the river was in an unimproved state.

The work done has been that of clearing the channel of rocks, snags, stumps, etc., and the banks of overhanging trees, while with special reference to push-boat interests, channels have been cut through the ripples or shoals.

The Government has improved this river from its mouth at Louisa to Baileys Dam, a distance of 100 miles.

As the roads through the mountains are little more than trails, they are entirely unfitted for freighting purposes, so that the people along the river, and particularly those well up the stream, are almost dependent upon water transportation for obtaining supplies, etc. The lower portions of the river are reached by steamboats, but above steamboat navigation push boats alone can be used, and little channels have been made through the shoals and ripples in the past for their passage. This kind of navigation may appear to be of comparatively little account, but gains in importance materially when it is considered that it furnishes the only means of communication for obtaining supplies.

Again, the Tug being a small stream of steep slope, with rocky banks in many places, it is dangerous to run rafts in high rises, owing to the difficulties of management due to sharp bends and swift currents; consequently, timber is brought out only on moderate rises, and, preferably, on a falling river.

The Norfolk and Western Railroad follows the right bank of the river for some distance, and its construction has, to a greater or less extent, affected the navigable capacity of 22 miles of the river from the upper limit of the improved portion down. In clearing the right of way and grading, stumps and trees were rolled into the river, and large quantities of rock were blasted into the stream. It is claimed by the railroad people that these obstructions have been removed, and that the river is in good condition again; rivermen deny this, and an inspection, when the river gets sufficiently low, will alone determine the situation.

Under date of July 1, 1891, the Norfolk and Western Railroad *et. al.* were perpetually enjoined from obstructing the navigation of the Tug Fork, and ordered to remove obstructions already created by them before the 15th day of November, 1891; and, furthermore, they were permitted to go forward with the construction of the road, and if any rocks, trees, etc., were accidentally or from necessity thrown into the stream, they were to be removed within three months; and, finally, all said rock, stone; trees, logs, lumber, timber, and débris were to be removed before November 15, 1892. A bond of $25,000 was required for faithful compliance with the decree. On August 2, 1893, I inspected that portion of the river which had been obstructed by the railroad company during its construction, and found that the obstructions placed therein by the company and its contractors had been removed.

It may be stated that the improvement of this stream is not permanent in its character, as the obstructions, such as snags, sunken logs, etc., are liable to re-form each year.

The report of Assistant Engineer Thomas, appended hereto, gives details of work done during the past fiscal year.

APPROPRIATIONS.

June 14, 1880	$2,500
March 3, 1881	2,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	3,750
September 19, 1890	2,500
July 13, 1892	2,500
Total	23,250

Money statement.

July 1, 1893, balance unexpended	$833.61
June 30, 1894, amount expended during fiscal year	796.37
July 1, 1894, balance unexpended	36.64
July 1, 1894, outstanding liabilities	.51
July 1, 1894, balance available	36.13
Amount that can be profitably expended in fiscal year ending June 30, 1896. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1883.	2,500.00

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1894.*

MAJOR: A party in charge of Capt. James Welch was sent out on Tug Fork about the 1st of August to clear the channel of such obstructions as had come into it during the winter and spring, and to put the shoals in better condition for navigation.

Work was done at Mill Creek, Vinson Rocks, Mulberry Shoal, Coldwater Branch, Lost Creek, Copley Shoal, Endicott Shoal, Calf Creek, Lick Shoal, Buck Creek, Wolf Shoal, Yocey Sluice, John Parsley Shoal, Long Branch Shoal, Carter Ripples, Pigeon Shoal, White House Shoal, Mount Sterling Shoal, Joe Dempsey Shoal, Coleman Shoal, Big Creek Shoal, Jim Taylor Shoal, Alley Island, and Sugartree Falls. One hundred and seventy-six snags, 81 trees, 219 stumps, 608 cubic yards of solid rock, and 2,001 cubic yards of loose rock were removed, and 14 trees were topped.

The river was left in excellent condition for navigation on all the navigable portion of it, about 60 miles, and, if the appropriations are continued as they have been, it can be kept in good order.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

NOTE.—Commercial statistics included in the report for improving Big Sandy River, West Virginia and Kentucky.

H H 12.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA

The Guyandotte River rises in the southwestern part of West Virginia, and, flowing in a northwesterly direction, empties into the Ohio 12 miles above the mouth of the Big Sandy, and 39 miles below the mouth of the Great Kanawha.

The project for the improvement was adopted in 1878, and contemplated the obtaining of a clear channel with a width of 30 feet, and a least depth of 18 inches during five months of the year by the removal of rocks, snags, and other obstructions. This river was practically closed before work commenced, except during rises of considerable height.

The stream was once improved by the State of Virginia by the construction of 6 locks and dams. The locks were constructed of timber, and, as a matter of course, after a time, the charges for repairs rendered necessary by the natural decay of the wood became very great, and a little further along the system was abandoned, and what had formerly constituted a useful improvement now became obstructions. The old locks and dams were carried away in part from time to time by floods, so that when the first report on this river was made by Maj. William E. Merrill, in 1875, most of them had been partially washed away, but the ruins of one still constituted the worst obstruction on the river.

There are two milldams—Pecks, 7 miles below Logan, and Lamberts, 19 miles below Pecks—that still constitute serious obstructions to navigation, and have been reported to the Department as such. The authority for their construction in the first place was based upon a permit from the circuit court, and their continuance has been a nuisance and constant damage to the river interests.

The work in previous years has been to cut passageways through the old dams where required, make channels through the shoals for push boats, and remove such obstructions as rocks, snags, logs, stumps, etc., existing in the channel of the river, as would interfere with rafting at ordinary and low rafting stages.

The stream is incapable of permanent improvement, as the obstructions in the channel, such as trees, snags, logs, etc., are liable to re-form. The stream up to Logan, a distance of 81½ miles, has an average fall of about 22 inches to the mile.

No work was done during the past fiscal year, the balance, $54.36, being so small.

APPROPRIATIONS.

June 18, 1878	$2,000	August 11, 1888	$2,000
March 3, 1879	1,000	September 19, 1890	2,000
June 14, 1880	2,000	July 13, 1892	2,000
March 3, 1881	3,500		
August 2, 1882	2,000	Total	18,500
July 5, 1884 *	2,000		

Money statement.

July 1, 1893, balance unexpended	$54.36
June 30, 1894, amount expended during fiscal year	26.08
July 1, 1894, balance unexpended	28.28
July 1, 1894, outstanding liabilities	.25
July 1, 1894, balance available	28.03
Amount that can be profitably expended in fiscal year ending June 30, 1896	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

* Made available by act of August 5, 1886.

Commercial statistics for fiscal year ending June 30, 1894, Guyandotte River, West Virginia.

Articles.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cross-ties		12,500	60,000	40,000
Timber	60,000	90,000	120,940	100,000
Miscellaneous	1,128	1,300	1,310	1,221
Total	61,128	103,800	182,250	141,221

List of boats plying on Guyandotte River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
J. T. Hustler	Side-wheel	75	16	2.2	16.68
Favorite *	do	103	14.8	2.5	43.64

* New line.

H H 13.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

The Little Kanawha drains the central portion of West Virginia, rising in Upshur County. Its course is a little north of west, and it empties into the Ohio at Parkersburg; its total length is about 150 miles.

The Little Kanawha Navigation Company owns and operates four locks and dams on this river, which furnish slack-water navigation from the Ohio up to a point 2 miles above the village of Burning Springs where the United States lock is located, but the service of this system is very poor, owing to the dilapidated condition of both locks and dams. Breaks and washouts are of frequent occurrence during high water, and the interruption to navigation is in consequence expensive and harassing.

The present project for the improvement of this river, adopted in 1876 and modified in 1880, contemplates the construction of a lock and dam to extend slack-water navigation for a draft of 4 feet a distance of 12 miles above the point reached by the navigation company, and the improvement of the natural channel of the upper river by the removal of obstructions, etc., for a distance of 80 miles, the object of the latter being to obtain a channel of a minimum width of 40 feet, with a depth of 2 feet for at least four months in each year.

The lock and dam for extending slack-water navigation above the works of the Little Kanawha Navigation Company are completed, the lock having been opened to navigation December 2, 1891. This gives, theoretically, 4 feet navigation to and a little above the mouth of the west fork.

During low water the lower miter sill is sometimes out of water, owing to the leaking of the dams of the Little Kanawha Navigation Company. The dam at Palestine, 9 miles below Burning Springs, is particularly bad, so that, at times, when water is running over the crest of No. 5, the upper surface of the lower miter sill of the lock will be out of water fully 6 inches.

APPROPRIATIONS.

August 14, 1876	$7,300	August 5, 1886	$16,875
June 18, 1878	18,000	August 11, 1888	25,000
March 3, 1879	18,000	September 19, 1890	40,000
June 14, 1880	15,000		
March 3, 1881	40,000	Total	211,175
August 2, 1882	31,000		

Money statement.

July 1, 1893, balance unexpended	$263.17
June 30, 1894, amount expended during fiscal year	238.29
July 1, 1894, balance unexpended	24.88
July 1, 1894, outstanding liabilities	1.60
July 1, 1894, balance available	23.28

NOTE.—For commercial statistics and list of boats, see report for operating and care, etc., Little Kanawha River, West Virginia.

H H 14.

OPERATING AND KEEPING IN REPAIR THE LOCK ON LITTLE KANAWHA RIVER, WEST VIRGINIA.

This lock, known as No. 5, is located about 42 miles from the mouth of the river, and above the four locks and dams owned and operated by the Little Kanawha Navigation Company. It was opened to navigation December 2, 1891, and since that time, with the exception of a few days, has been in condition to be operated continuously.

During very low water the pool below the lock is lowered, on account of the leaking of the company's dam below Burning Springs, at times to such an extent that the lower miter sill of the lock shows above the water's surface.

During the past year the bank below the lock was protected by riprap, and also the bank above the abutment. A few pieces of sheeting were replaced on the dam, and the gate bonnets were repaired.

ALLOTMENTS.

1892	$1,500.00
1893	4,426.65
1894	3,837.97
Total	9,764.62

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Little Kanawha River, West Virginia, improved by lock and dam, during the fiscal year ending June 30, 1894.

Months.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1893.				
July	$95.00			$95.00
August			$16.75	16.75
September	490.00	$197.35		687.35
October	145.00		20.60	165.60
November	295.00		37.60	332.60
December	295.00			295.00
1894.				
January	190.00			190.00
February			37.60	37.60
March	95.00	80.05		175.05
April	145.00	2.94	27.75	175.69
May	95.00	46.85	37.60	179.45
June	95.00		.23	95.23
Total	1,940.00	327.19	178.13	2,445.32

Commercial statistics for fiscal year ending June 30, 1894, Little Kanawha River, West Virginia.

Articles.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Coal	1,100	10,507	3,100	1,280	644
Lumber	8,540	28,677	20,486	18,720	8,522
Oil	678	1,450	1,738	666	1,230
Staves	24,500	26,964	10,050	8,470	22,113
Timber	70,000	59,703	109,337	48,386	47,250
Ties, railroad	27,650	48,312	92,200	53,500	21,923
Passengers	1,563	1,500	1,343	1,450	1,200
Miscellaneous	6,084	13,575	6,000	4,600	3,500
Total	140,115	190,688	244,254	137,072	106,412

List of boats plying on Little Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Oneida	Stern-wheel	104	19.5	4.2	75.78
W. A. Hilton	do	105	22.5	3.6	67.54
D. T. Watson (tow)	do	99	17	2.6	80.45
J. King (tow)	do	90	15	3	34.93
Mary E. (tow)	do	86	13.6	3.6	19.34
Lulu F. (tow)	do	98.4	15.1	2.6	37.16

Report of lockages on Little Kanawha River, West Virginia, for the fiscal year ending June 30, 1894.

Lock.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing.	Total number lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 5	323	42	350	100	132	347	98	1,174	148	2,343	1,894

NOTE.—Suspension of navigation caused by lack of water in the pools of the Little Kanawha Navigation Company.

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